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Guidelines for Low Cost Subsurface Sonar Imaging
Ottawa River / Quyon, Québec, Test Case

C. Prévost

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Guidelines for low cost subsurface sonar imaging Ottawa River/Quyon, Québec, test case

Note:
This document is a follow-up to an initiative started few years ago. The goal was to utilize consumer grade depth sounders and low cost software to acquire large quantities of water depth points. These depth points were then used to generate a bathymetric model of water bodies, to evaluate the water volume supply of lakes within Nunavut communities. The reader will find at the end of this document (page 36), a list of publications related to this initiative.

The topic of side scan imaging sonar discussed herein can be considered as an extension and a significant improvement of the initial initiative, since it is now possible to produce a detailed image map of the water floor. As a consequence, this new generation of consumer grade sounders opens the way to new and unexpected technological applications.

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Abstract

Natural Resources Canada (NRCAN) has the mandate of providing essential geographic information. An improved knowledge of our physical environment represents one of the basis of this mandate. This essential baseline information is generally associated with the terrestrial or landmass environment. The geographic knowledge of the underwater environment often represents the weak segment in the chain linking terrestrial units together. In the geohazard domain, also a NRCAN mandate, the development of mitigation strategies for geohazards, including landslide, rely on accurate underwater terrain information.

Recently, there have been consumer grade, low cost, side scan imaging sonars capable of imaging the floor of a lake, a river or a coastline. These tools are targeted for sport fishing and diving markets but they are also capable of partly providing an image view of the lake and river floor. These tools, which are versatile, portable and easy to use can have scientific and technological applications, such as the subsurface geomorphological mapping of lake and river floors: bedrock outline, contact between sediments and bedrock, lineaments, sand waves location and various forms of erosion / deposit. Therefore, low cost consumer grade side scan sonars can partly fill the technology / scientific information gap for essential geographic information and geohazards, and are particularly well suited for the Canadian North and in remote or difficult to access areas.

A case study was carried out in Quyon (Québec) area, in the Ottawa region, to determine the potential of these tools for the geomorphological mapping of a river floor, as it may relate to landslide characterization in the area. This document explains the main constraints for a high quality survey and recommends ways to overcome them. It also provides guidelines for image acquisition. Several image examples and interpretation are presented as well as the findings resulting from this case study.

Keywords: Imaging sonar, Interpretation, Processing, Landslide, Geohazard, Guidelines

List of figures :

1) Introduction

Natural Resources Canada (NRCAN) has the mandate of providing essential geographic information. A better knowledge of our physical environment represents one of the basis of this mandate. This essential information is generally associated with the terrestrial or landmass environment. The geographic knowledge of the underwater environment often represents the weak segment in the chain linking terrestrial units together. In the same vein, research on geohazards, which includes landslides, is also part of NRCAN's mandate. An information gap can sometimes occur when a geohazard includes both land and water environments (river, lake or coastal).

Within the last few years there have been consumer grade, low cost, side scan imaging sonars capable of imaging the floor of a lake, a river or a coastline available. These tools are targeted for sport fishing and diving markets. The imagery is usually looked at in real time or off line directly from the sonar display device. It is possible however to save and export the data for further processing to generate an image map of water body floors.

These imaging sonars look similar to traditional GPS fish finders, well known by the fishing community. They are portable and can be installed within a few minutes on a wide variety of watercrafts: kayaks, inflatable boats, canoes, rowboats, pontoons, etc.

These imaging sonars (also named side scan imaging sonars) are sold for less $ 3000, and are made out of an acoustic transducer (transmitter / receiver), a GPS receiver, and a processing and recording unit (Figures 1 & 2). The device being targeted to the general public is robust and easy to use, thanks to user guides and numerous promotional videos. On the other hand, documentation is limited on internal data processing methodologies and other technical considerations.

Depending on the model, consumer grade side scan imaging sonars can provide an image covering up to 50 meters on each side of the boat, and can image down to 40-50 meters. On the sonar screen display, the boat location is displayed in the centre. The water column is represented by a black strip of variable width depending on the depth of water. Finally, the sonar image of the water floor is displayed on each side of the black strip (Figures 3 & 4)

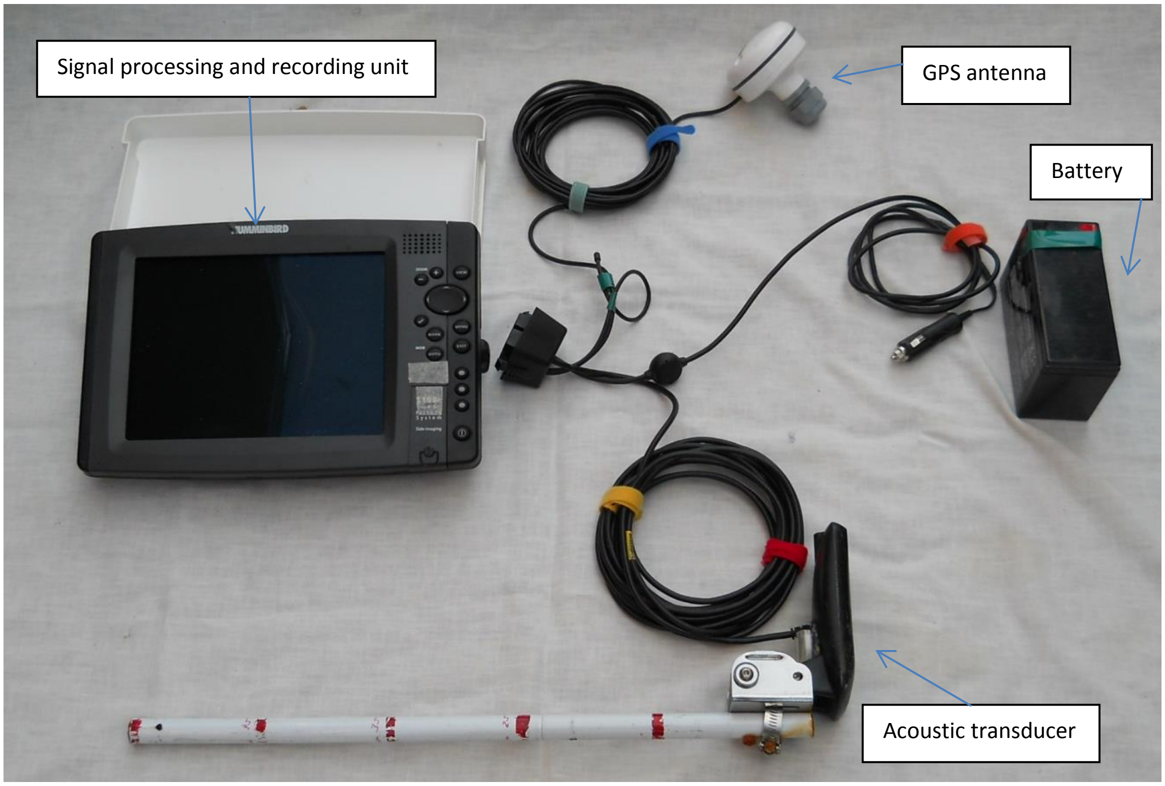

Figure 1. Components of a consumer grade side scan imaging sonar.

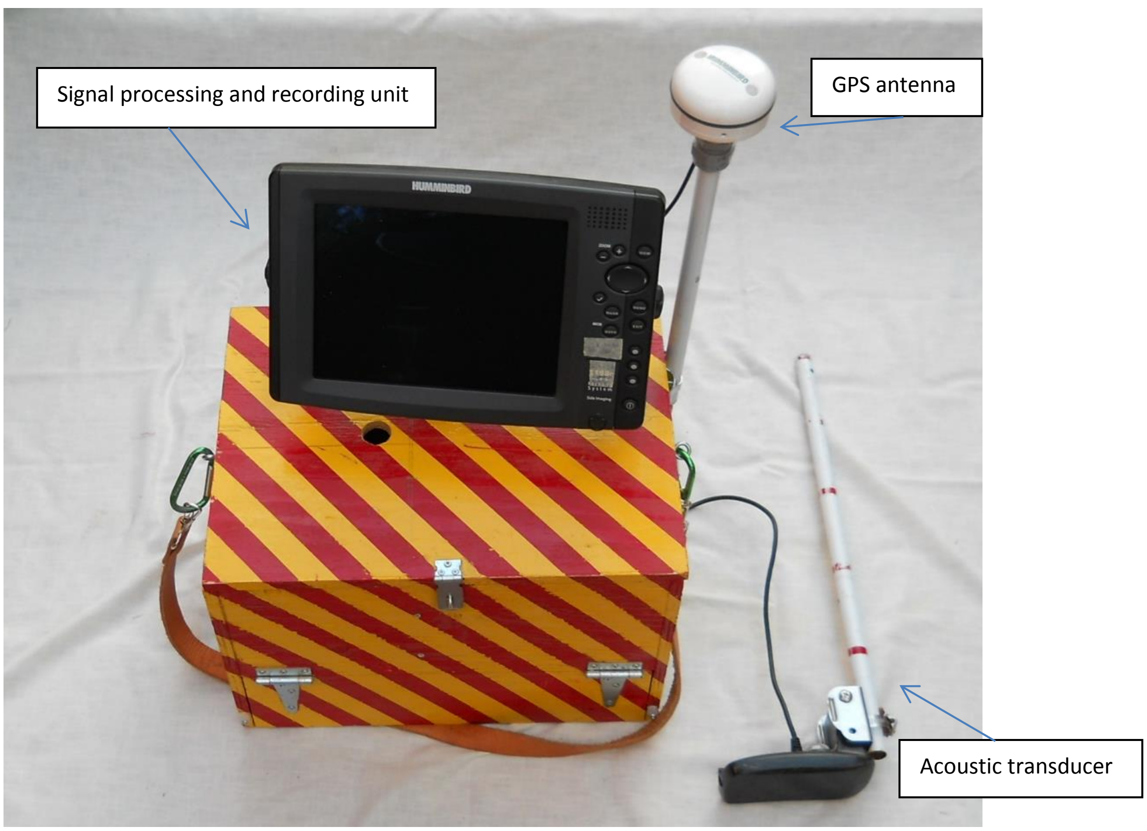

Figure 2. Components of a consumer grade side scan imaging sonar and transport /operation box.

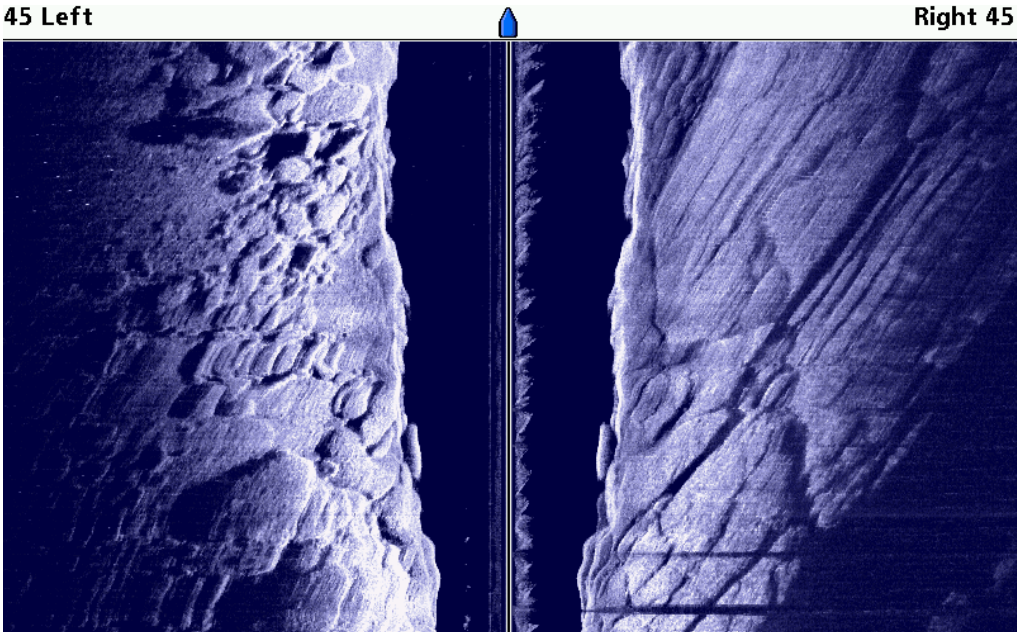

Figure 3. Screen capture of sonar display. The image was acquired at the foot of a rocky cliff in 11 metres of water. The rocky cliff is on the right and the boulders are on the left..

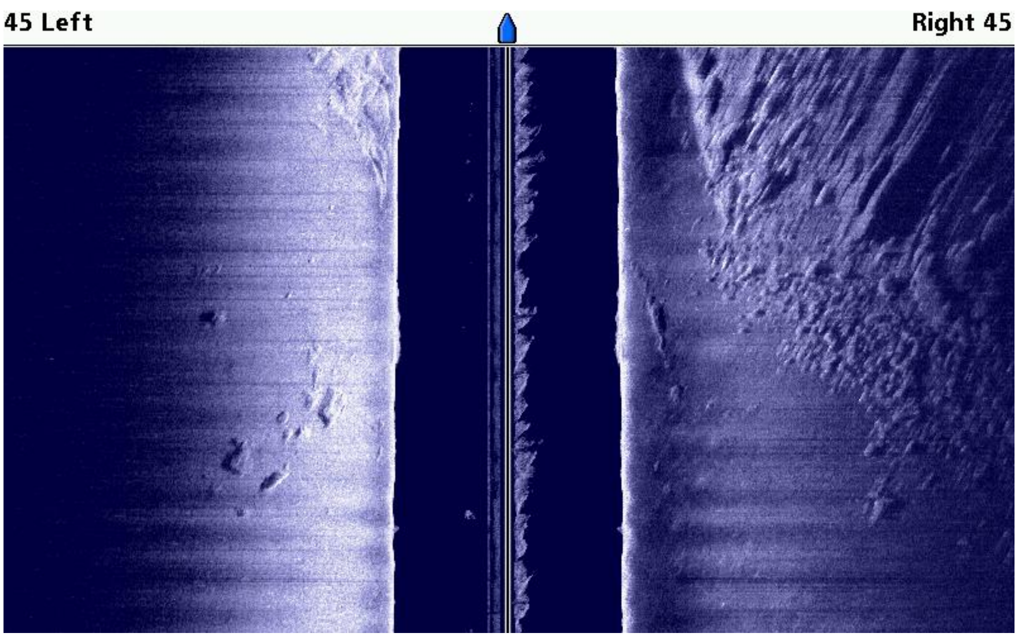

Figure 4. Screen capture of sonar display. The image was acquired at the foot of a rocky cliff in 10 metres of water. The contact between surficial deposit and bedrock is visible.

One rapidly understands that these low cost and versatile tools can have several scientific and technological applications, such as the geomorphological mapping of lake and river floors. The analysis of numerous images confirms the capability of sonar imagery to map the bedrock outline, contact between sediments and bedrock, lineaments, sand wave locations and various forms of erosion / deposit (Figure 5). On the other hand, promotional documents often highlight the use of these tools to identify man made features: sunken boats, material, containers, etc., which may have unexpected applications in the environmental domain particularly in the Canadian North.

Finally, it is possible to envision the adaptation of this technique for other applications, notably in the field of geohazard mapping, for several locations around the world.

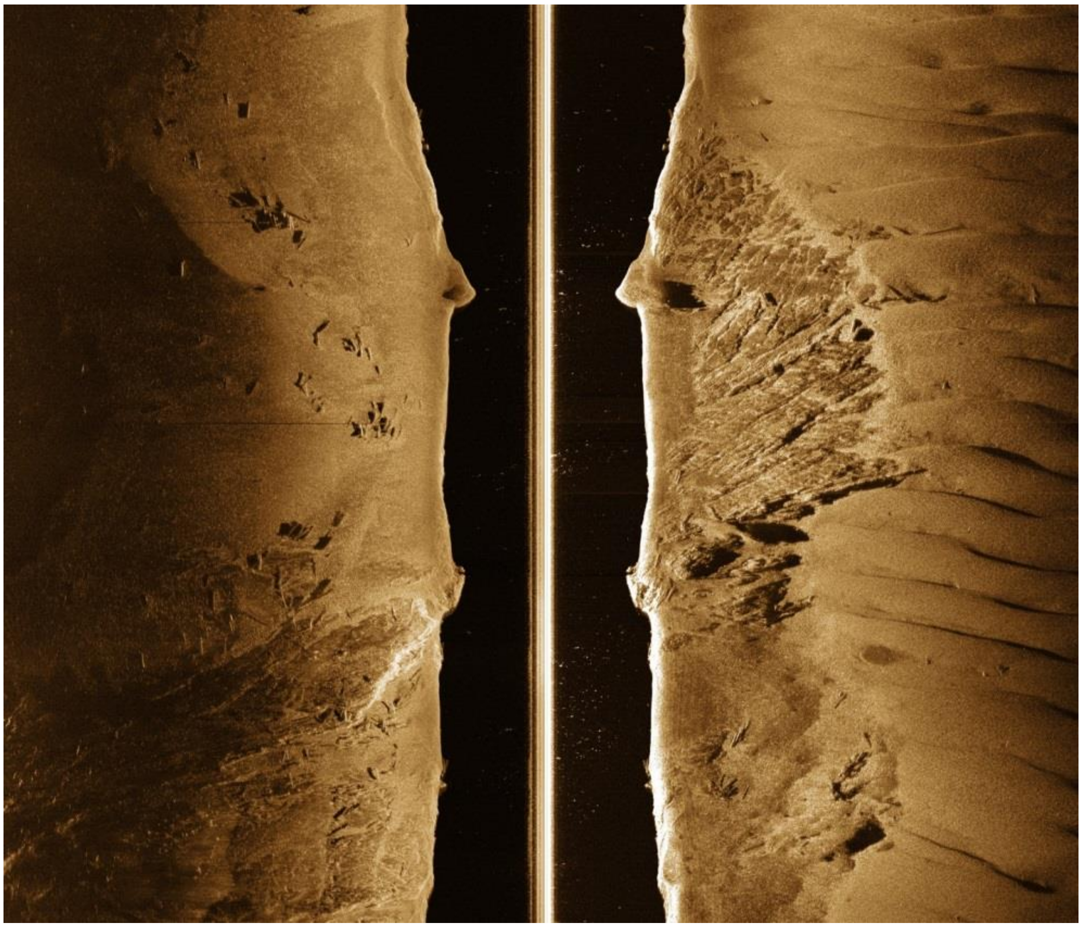

Figure 5. Consumer grade side scan imaging sonars are meant to be user friendly, but may not fully match scientific requirements. However, they can, to a certain extent, allow us to discover what is hidden at the bottom of lakes and rivers, as shown on this image acquired on a river. The contact between surficial deposits and bedrock is clearly visible. Wood logs, possibly remnants of the ‘’drive’’ era are also visible on left.

2) Operation

When used in operation on board a watercraft (Figure 6), the side scan imaging sonar transmits a focussed acoustic wave on each side of the boat at a frequency of 800 kHz and at a rate of 10 pulses (called ‘’ping’’) per second (Figure 7). Depending on the setup chosen and depth of the water, the width of the area observed will be a few tens of meters on each side of the boat (40 meters in the illustrations in this document). When the acoustic signal returns to the system, it is ‘’chopped’’ by time interval; this determines the lateral resolution, which can be of a few centimeters. The along track resolution, on the other hand, is determined by the forward motion of the boat and the degree of overlap of beam returns. The documentation suggests an optimum speed of 3 to 7 km/h (2-4 kn).

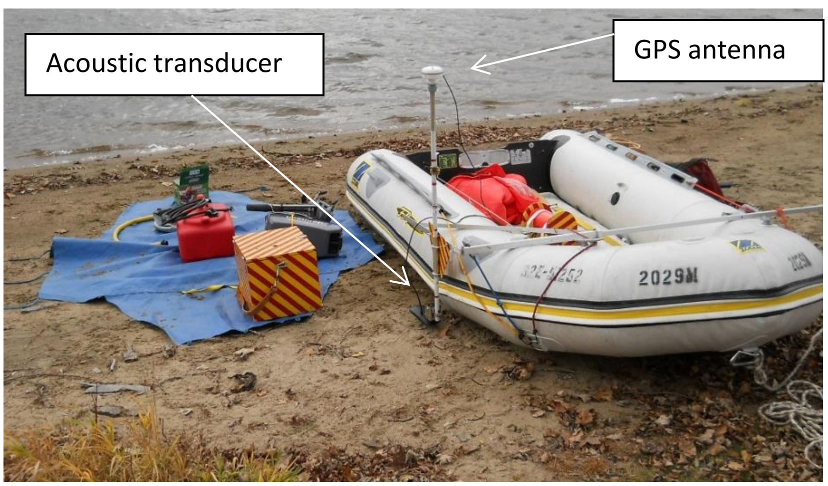

Figure 6. Setup of a consumer grade side scan imaging sonar survey.

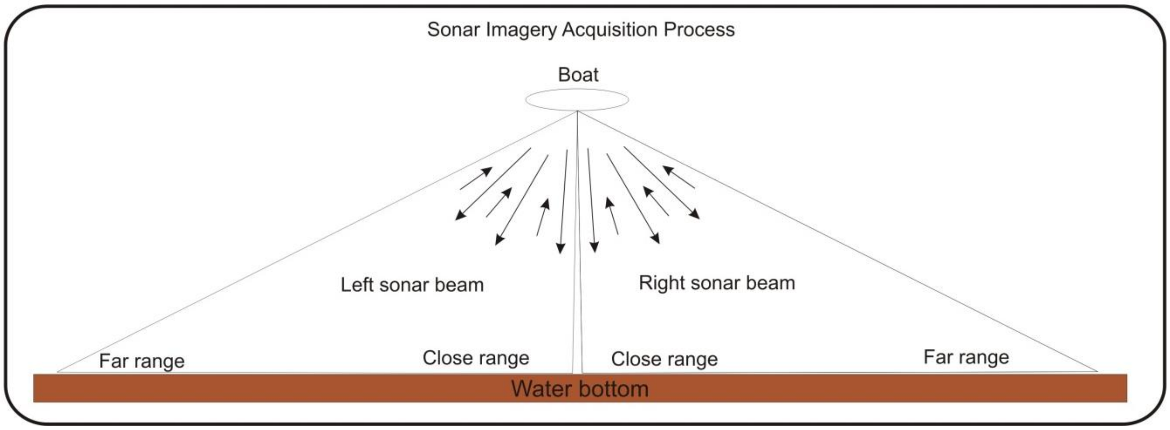

Figure 7. Side scan sonar imagery acquisition schematic; left and right beam

3) Data acquisition

The size of the boat, its navigation parameters, and its degrees of freedom of movement leads to data acquisition constraints for cartographic purposes. These constraints, which may have an effect on the output data quality are, in order of importance:

1) Yaw
2) Roll
3) Speed of forward motion.

To achieve a quality product, the geometry of acquisition dictates that the operator must progress in a straight line, and in parallel transects, spaced by a distance such that there is overlap between survey passes, allowing the user to cover the whole survey area.

Yaw is a fast change in bearing resulting in a sinuous trajectory. The sonar beams are not parallel in the lateral direction then, creating an image of poor quality. The operator must ensure that the survey plan, surface conditions and wind direction are adequate to make the survey transects truly straight and parallel.

Roll is a rotation of the boat, and the acoustic transducer attached to it, around the forward motion axis of the boat. Roll is often the result of lateral waves caused by cross wind or boats navigating close by. The operator must ensure to have an alternate survey plan of a different orientation to mitigate wave induced roll effects.

The speed of forward motion has a direct impact on the along track image resolution.

A slow speed produces images of better quality but takes more time. Test surveys were performed at a speed of 9 km/h (5 kn) and 5 km/h (2.7 kn), allowing for a significant improvement in image quality. It is estimated that a survey at 3-4 km/h (2kn) would be optimal. It must be noted however that there is a minimal speed, variable depending on circumstances and boat type, required for the operator to keep the navigation parameters constant (Figures 8 & 9).

The following section on data processing illustrates the importance of having the lowest impact of the three constraints described above.

4) Data processing

To date, there are only a few low cost software which can process consumer grade side scan sonar data to generate GIS compatible quality products from the on board recorded data.

The principle of operation of a side scan sonar mimics to a certain extent the principle of operation of a real aperture airborne radar. Therefore, due to their mode of acquisition, the sonar data have geometric distortions associated with the slant range acquisition (Figures 10 & 11). Also, likewise the antenna pattern of an airborne radar which has an effect on the return beam intensity, the beam return pattern of the sonar produce images with brighter returns in the close range and darker returns in the far range (Figure 12).

Moreover, data must be geocoded and the process must account for the variation in the speed of the boat. The GPS receiver of the sonar is used for this purpose. Finally, the resulting images must be enhanced, to increase their contrast for ease of interpretation. (Figure 13 & 14).

Figure 8. Survey path of a consumer grade side scan sonar overlaid on an air photo.

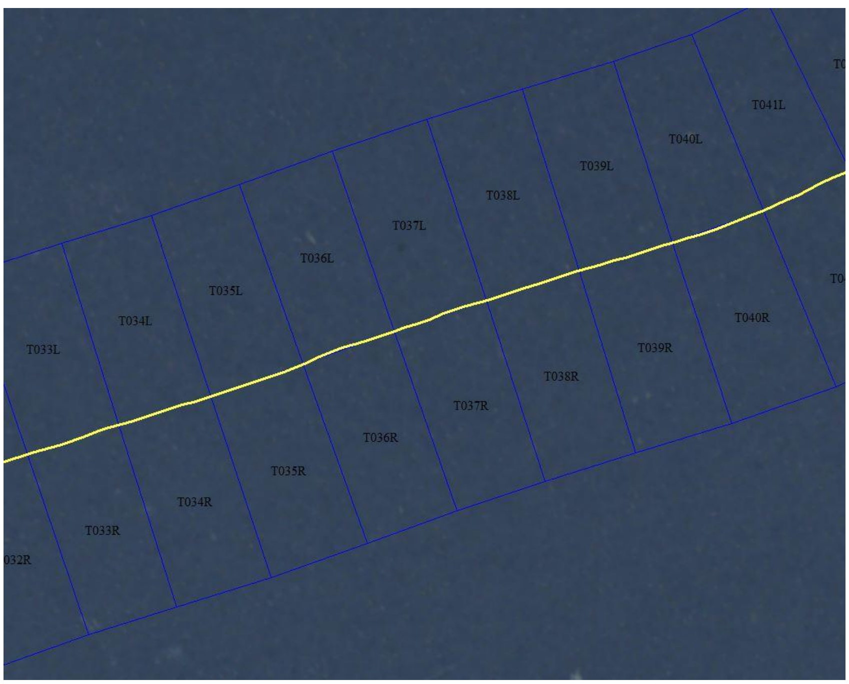

Figure 9. Enlargement of the previous figure. The boat trajectory, as recorded by the onboard GPS, is shown in yellow. Note the outline of the data from the left beam and the right beam. The processing software cut the data in consecutive tiles .

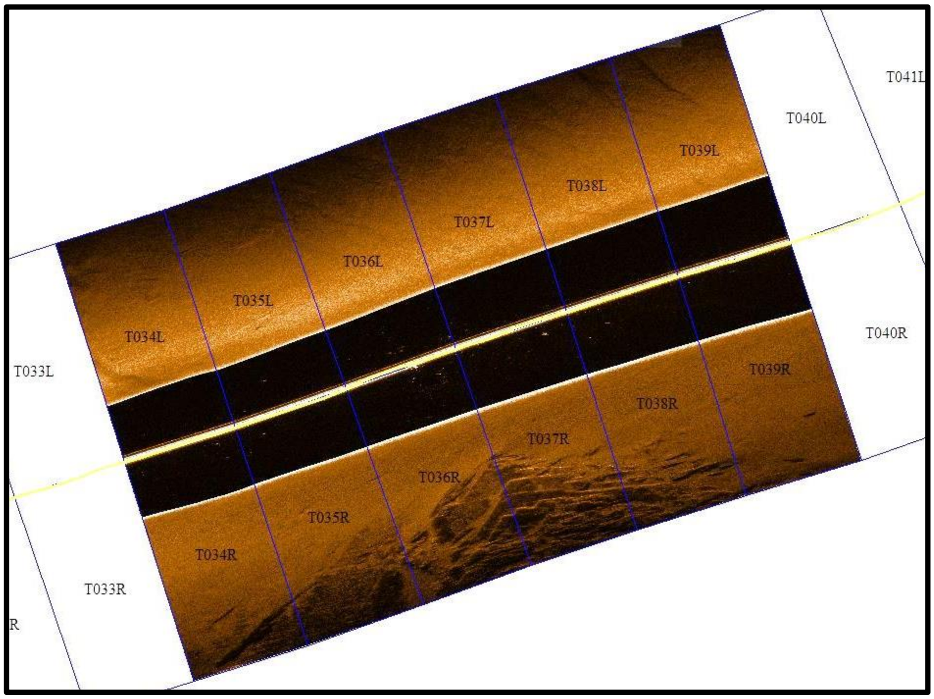

Figure 10. Example of a portion of a raw survey line - right sonar beam and left sonar beam. The water column is shown as the black zone at the center.

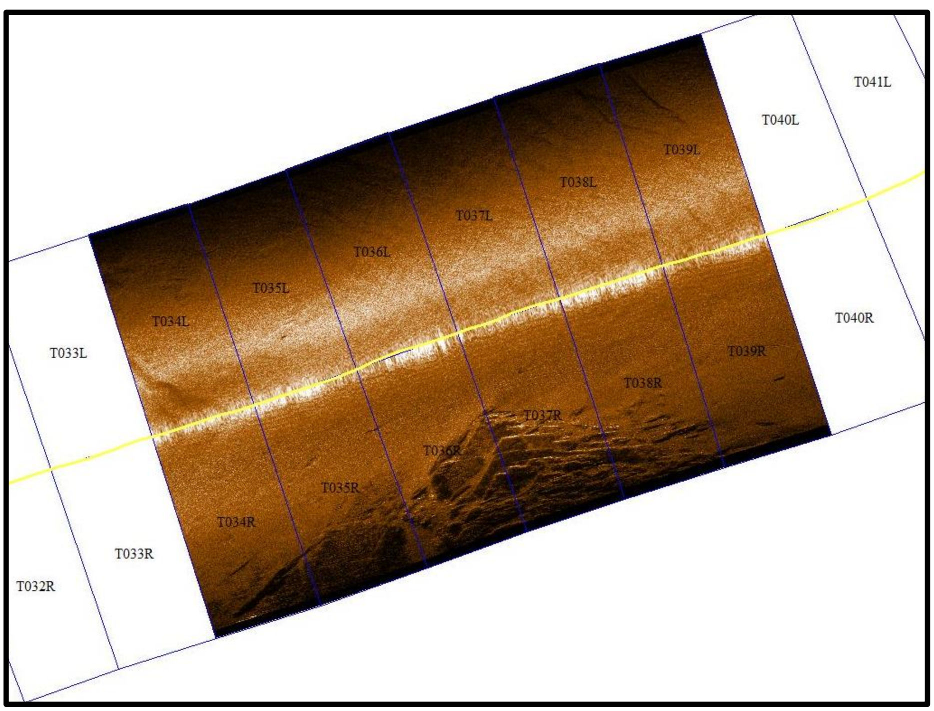

Figure 11. Image of the previous figure for which geometric distortions associated with the slant angle of acquisition have been corrected. This has also eliminated the black zone associated with the water column.

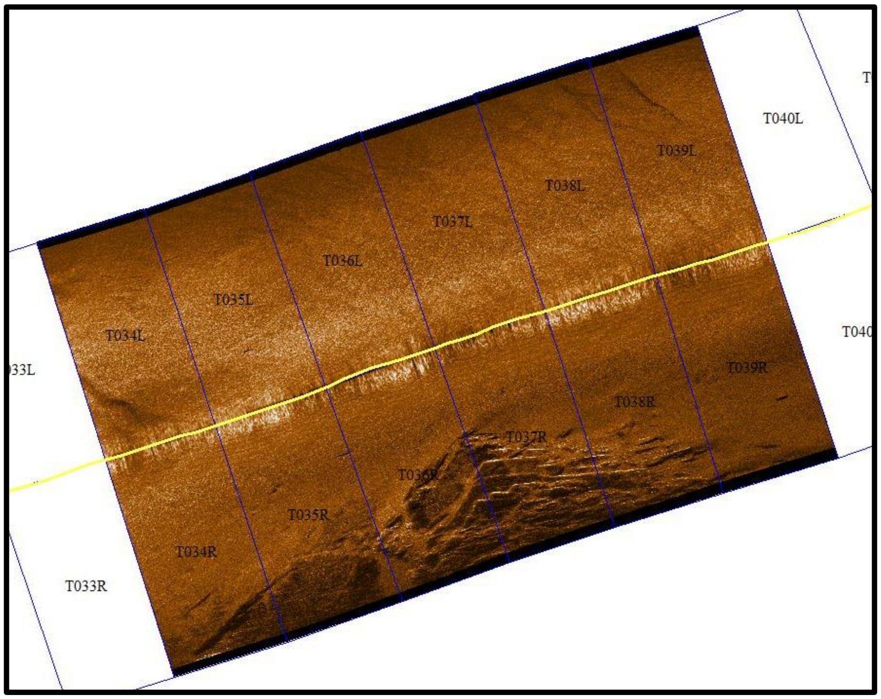

Figure 12. Image of the previous figure for which the return beam intensity pattern has been corrected.


Figure 13. Final product corrected and geocoded, compatible with GIS software.

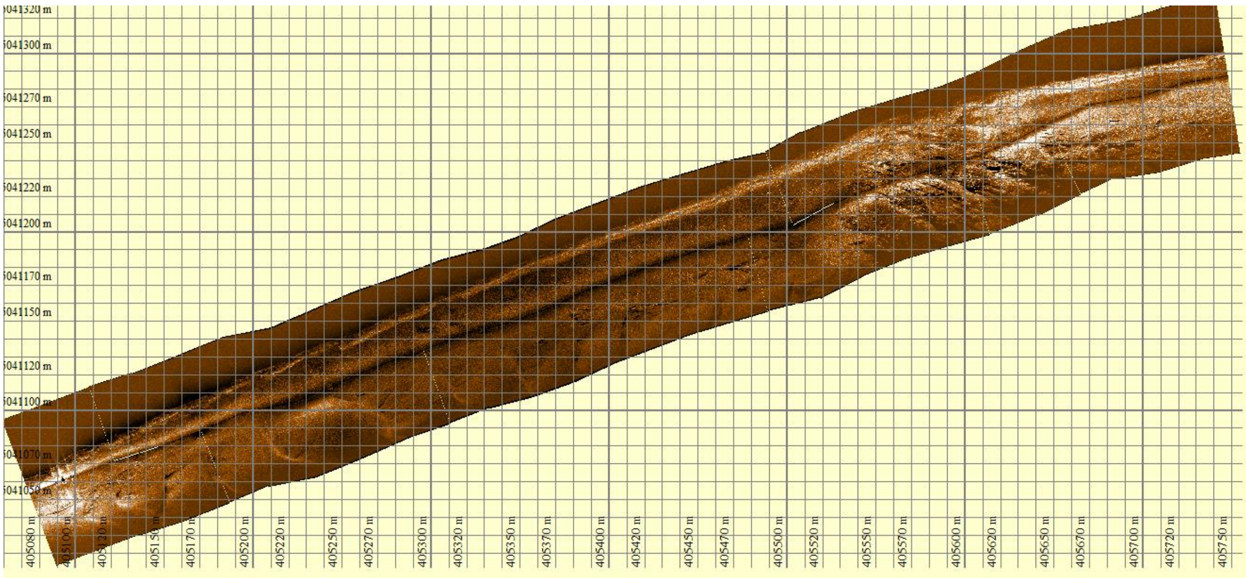

Figure 14. Complete geocoded survey line.

5) Workflow consideration : From survey plan to final image map

5.1) Survey Plan

The survey plan should be made of straight and parallel lines and the line spacing must allow for the production of mosaics with complete coverage of the area. If the design of the final product calls for single side viewing orientation (See Section 6.3) then the survey plan should be made in a way to have smaller line spacing.

The operator must ensure to have a backup survey plan, with different orientation, which will mitigate the lateral wave effect. One of the survey plans should be designed according to the dominant wind direction in the area.

5.2) Data acquisition considerations

- Temperature/meteorological conditions: temperature does not have any significant negative effects on the equipment. Consumer grade imaging sonars are built for fisherman and to be able to tolerate rain.

-Wind / Waves: wind must be non-existent or minimal. Wind generates waves, which induces roll, which in turn reduces the image quality. This constraint is likely the most difficult to overcome with low cost devices. For a survey on a lake or a river, the best time of day is likely to be early in the morning before the temperature increases and wind starts to pick up. In coastal areas the best time would be when there is minimal wind and the wind direction is optimal. For similar wind speeds it is known that waves will be smaller downwind from the coast, especially if the coast is a cliff. It is also recommended to try and select a day without any swell, which can be the consequence of faraway winds blowing days before. Several other considerations must be taken into account in coastal areas (tidal stand, littoral current, spring tides, etc.) but in the end, the optimal condition for a survey is a ‘’glassy sea’’.

-Tide height: there are no constraints related to tide height variation during the survey if it is compensated in altitude using external GPS data.

-Boat speed: acquisitions have been performed at 5-6 km/h with good results. It was realized *a posteriori* that the data quality would have benefitted from even a slower speed. A slow speed generates finer pixels in the along track direction. The along track pixel resolution is always coarser than the across track direction.

-Equipment condition: consumer grade side scan imaging sonars can operate in fresh or sea water. The speed of propagation of sound wave varies between these two different mediums. An option on the sonar allows the operator to select the appropriate water type.

-Type of boat: the type of boat has very little impact. The operator should favor a stable boat, which can maintain a bearing at slow speed and with lateral wind.   A low profile boat, such as an inflatable watercraft, ballasted at its centre provides good results.

5.3 Computer processing considerations

Whatever software is used, it must be capable of the following:

-Input raw data recorded by the sonar onboard device.

-Correct data for slant angle of acquisition; this angle varies from close range to far range.

-Correct for return beam intensity pattern. Some software identifies this function by the acronym BAC (*Beam Antenna Correction*), or SVG (*Signal Variable Gain*).

-Visually enhance the data, either by histogram analysis or a visual threshold

-Eliminate out of range data. The software should be capable of discarding data which exceeds a tolerance threshold. For example, data acquired during sharp turn or yawing.

-Geocode data.   This function can be of variable complexity depending on the software used and the capabilities of the imaging sonar. The sonar integrated GPS receiver is capable of providing the position of the boat every second. This allows to geocode the data with a precision of a few metres and allows for the compensation of variations in speed. However, consumer grade side scan sonars are not geared to acquire/record the information related to the attitude (yes, attitude not altitude) of the boat and use this information to correct errors due to pitch, roll and yaw.

When referring to the geometry of acquisition (Section 3), it is easy to realize the importance of this point. The low cost sonar data are always geocoded as if they would have been acquired in perfect conditions, i.e. without roll and yaw. Therefore, it becomes the responsibility of the operator to make sure data are acquired in these conditions to avoid generating poorly georeferenced output products.

It is worth noting that high end sonars are equipped with Inertial Navigation Systems which record platform attitude parameters (i.e. roll, yaw, pitch, etc.), which are used on high end processing software for precision geocoding.

Finally, some software is capable of ingesting high precision GPS positions acquired with external devices. Even though these GPS data can refine the sonar data position, they are of limited use to correct for roll and yaw errors.

5.4 Geomatic considerations

Low cost sonar processing software have limited capabilities for GIS processing and are sometimes designed to export processed data to viewing tools such as GoogleEarth^{tm}.

The implementation of a project aimed at mapping the river/lake/coastal floor should include the use of a GIS software to view each portion of the images, often called ''tiles''. This allows the users to choose the portions they want to use, either from the left side beam or the right side beam, crop the images and place them in a mosaic if required.

6) Case study : Ottawa River at Quyon, Québec.

A major earthflow occurred approximately 1000 years ago (*Brooks, 2013*) in sensitive marine clay close to Quyon in the Ottawa region, 50 km west of Ottawa/Gatineau (Figure 15). The earthflow likely carried material all the way down to the Ottawa River. As a consequence, there is a possibility that imprints/traces of the landslide still exist on the river floor, hence the interest of an exploratory side scan sonar survey in the area. The river is 350m in width and flows from west to east. A ferry crosses the river at Quyon (Figure 16).

A consumer grade side scan imaging sonar survey was undertaken at Quyon to:
-Understand and master the use of this low cost tool.
-Provide an overview of the structure of the river floor.
-Define extrapolation criteria of the technique on other water bodies, and coastal areas.

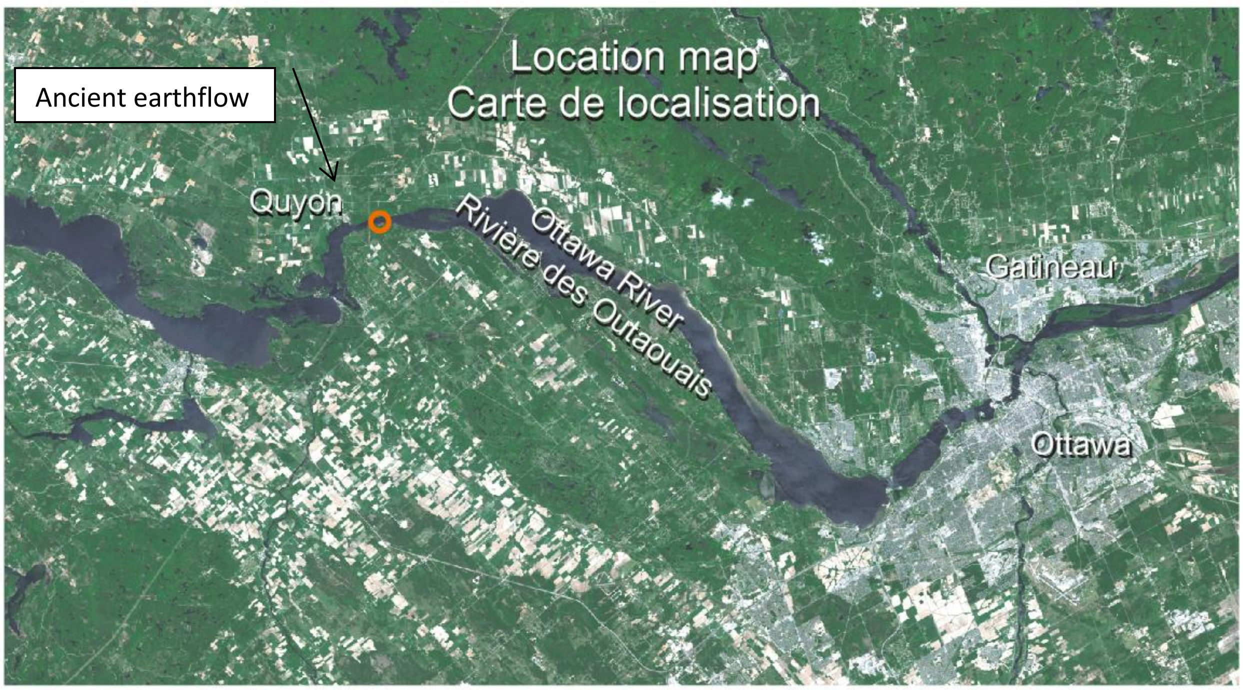

Figure 15. Location of the village of Quyon on the Ottawa River, upstream from Ottawa/Gatineau

Figure 16. Ottawa River, looking downstream from Quyon ferry.

6.1) <u>Survey planning</u>

Dominant winds were from west to east, thus the main survey plan was oriented in that direction. Moreover, the survey took place on a working day to reduce the possibility of waves induced by close /sport watercraft. The day of the survey was selected based on a weather forecast of zero to minimum wind (Figure 17).

Figure 17. Survey plan, Ottawa river, Quyon

6.2) <u>Survey with imaging sonar</u>

The consumer grade side scan imaging sonar survey was performed using a small inflatable boat. Survey lines were acquired in the upstream/downstream direction as well as across the river to evaluate the information content of imagery acquired in different orientations. The learning process of this consumer grade tool is very fast. However, the learning of its use in a scientific /technological context is more complex. In short, the operator configures a few basic parameters and starts the recorder. While navigating, the sonar images and the GPS data are recorded automatically and simultaneously on a memory card (Figure 18 &19).

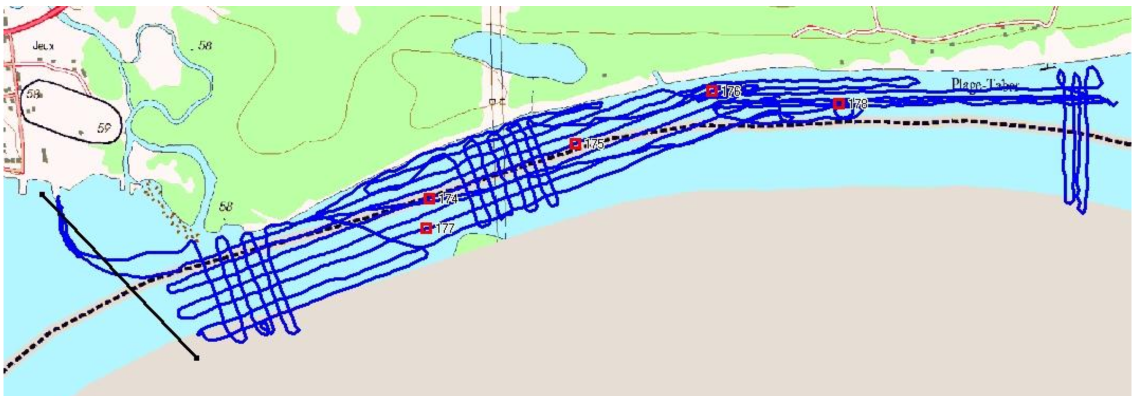

Figure 18. Survey lines, as recorded by the GPS on the sonar device

The survey was performed to provide the maximum amount of information on the structure of the river floor. The upstream/downstream surveys, with parallel lines, and very small spacing between them aim at producing a mosaic of geocoded images which would cover the whole area in a uniform viewing orientation. The survey across the river focused on defining the information content of these datasets.

Experience shows that survey line spacing could be reduced down to 10 metres. The ability of an operator to maintain a straight line bearing is limited to approximately 4 metres considering that he must rely on a real time GPS (imbedded in the sonar unit) for which the precision is approximately of 1-2 metres. Obtaining a high precision survey requires continuous attention from the operator.

In short, the survey must be made using transects that are as straight as possible, and at a slow and constant speed, despite wind and current.

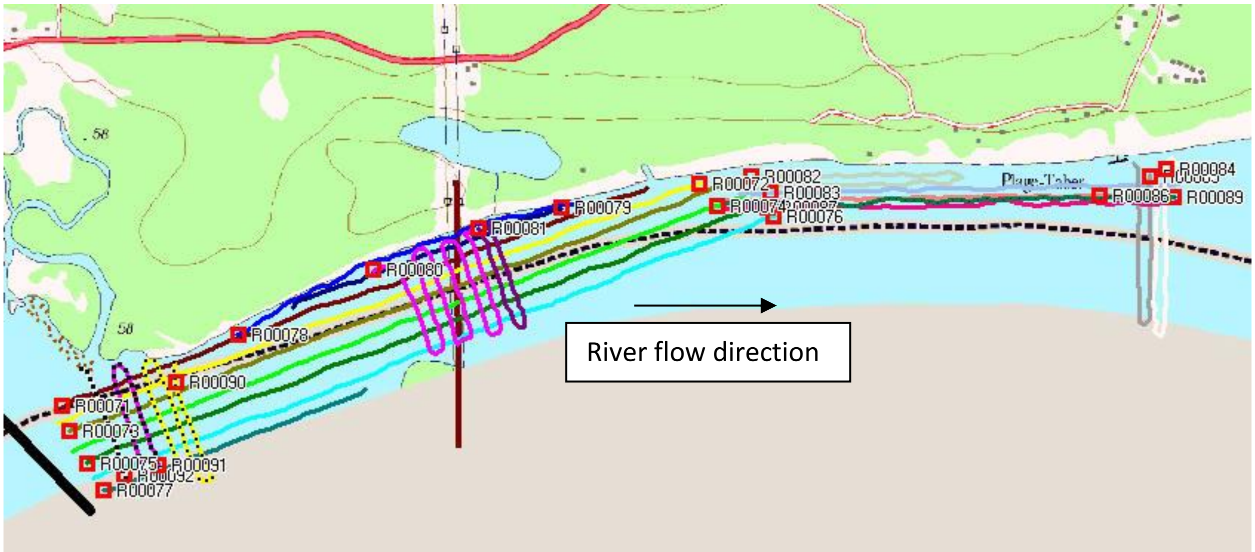

Figure 19. Individual survey lines on Ottawa River at Quyon.

A series of 21 survey lines were recorded for a total of 23 km, spread over 5 hours at a speed of approximately 5 km/h. It is worth noting that the river flows from left to right on the above figure. The imagery illustrates an interesting phenomenon associated with flow direction, especially for images acquired across the river (Figures 20 & 21).

The survey was made of survey lines of various lengths, and acquired from various orientations. The sequence starts at line #71 and ends at line #92. There is no #88 line.

Sonar files are huge, more information and availability is provided in Annexe 1.

Lines 71-79 were acquired in parallel, navigating **upstream and downstream** in the **western** zone of the survey site.

Lines 80-81were acquired **across** the river, in the **western** zone of the survey site.

Lines 82-83-86-87-89 were acquired in parallel, navigating **upstream and downstream** in the **eastern** zone of the survey site.

Lines 84-85 were acquired **across** the river, in the most **eastern** zone of the survey site.

Lines 90-92 were acquired **across** the river, in the most **western** zone of the survey site.

Figure 20. Processing result of a sonar survey line (line 73), overlaid on an airphoto.

Figure 21. Processing result of a sonar survey line acquired in the flow direction (line 73), and a line acquired across the river (line 81), overlaid on an airphoto.

6.3) Production of mosaic of images

At first, it is possible to overlay a mosaic of sonar images over a geocoded air photo to provide the geographical context of a project. It is worth noting that sonar imagery has a very fine resolution. As a consequence, printed products must be at a very detailed scale, such as 1:2000 or even 1:1000 to preserve the richness of the sonar dataset information.

Investigations have been undertaken to determine the best *modus operandi* for the generation of sonar mosaics. Side scan sonars have a left beam and a right beam, each of which produce an independent set of imagery. Sonar images, like radar images, convey a better rendition when viewed from the same orientation. The human eye and brain align themselves more easily when data are grouped by cardinal orientation. Therefore, the mosaic would benefit from being made of images acquired by the left beam or the right beam, depending of the travel directions, and in accordance with the planned viewing direction of the final product (Figures 22 & 23).

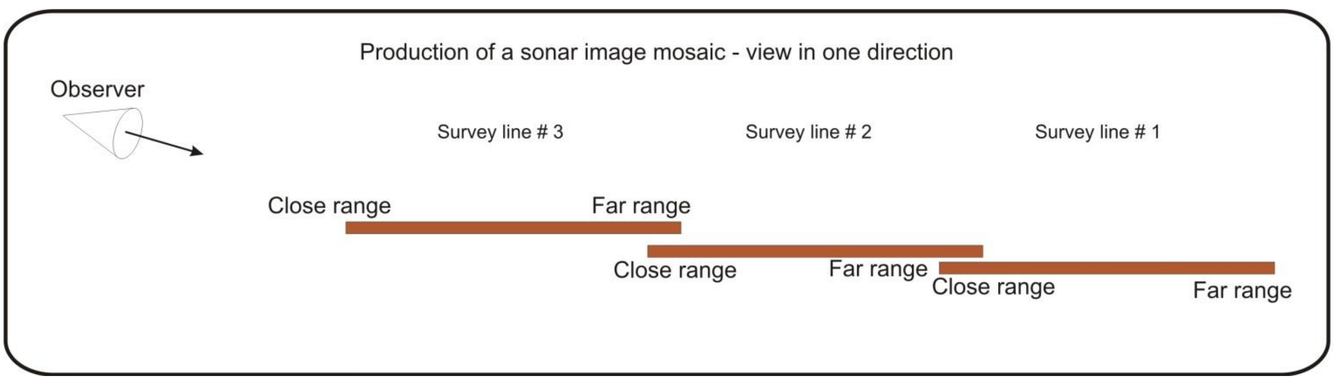

Figure 22. Schematic of the production of a mosaic of side scan images, all viewed from the same orientation.

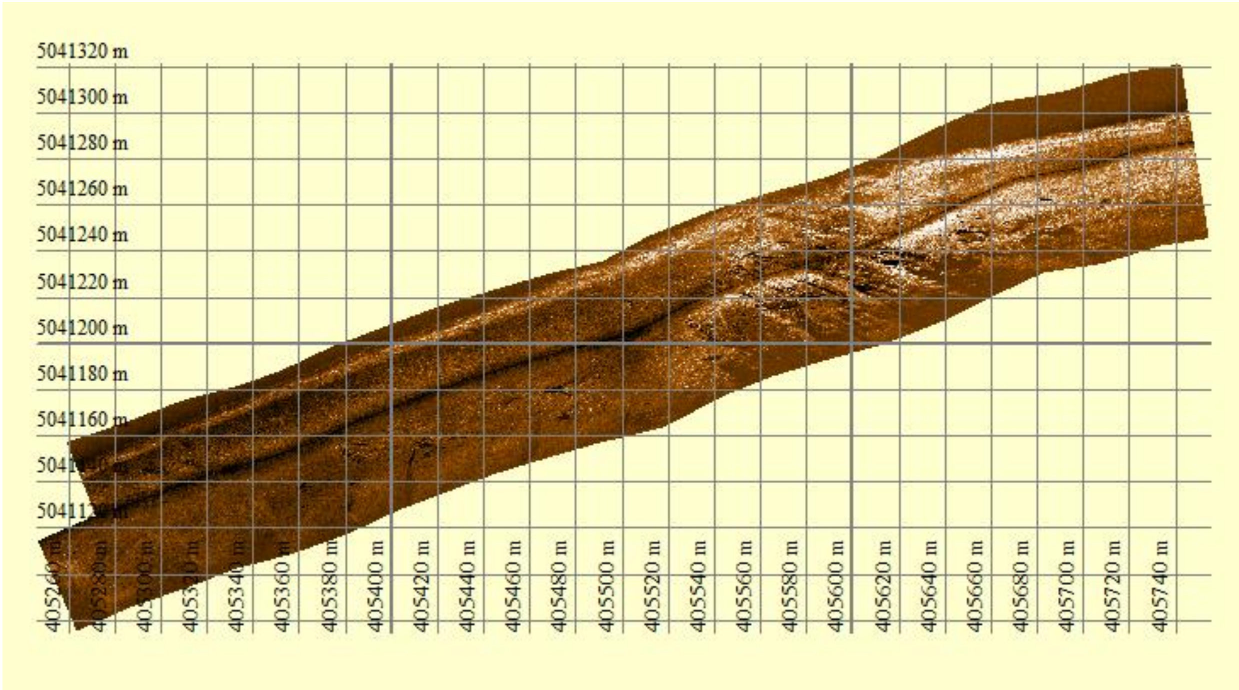

Figure 23. Example of a mosaic made of two survey lines.

In the first case, it was observed that for data acquired in east-west orientation (flow direction) the most revealing mosaic was made of images with a viewing geometry aimed towards the south. Moreover, if the survey lines are close enough, they can overlap like shingles. It was observed that the mosaic must be built in such a way that most southern images can be visually underlying, partially masked by the other images, which are superimposed. Observations show that the return sonar beam will be brighter on the northern side of the survey lines, and sonar shadows will be predominant on the southern side. This way, the human brain seems to recreate a form of lighting from the north orientation (Figures 24-25-26 and 27-28).

The analysis of figures 25 and 26 illustrate that it is possible to map the contact between bedrock and fluvial deposits. An unexplained protruding obstacle with its sediment trail is also visible.

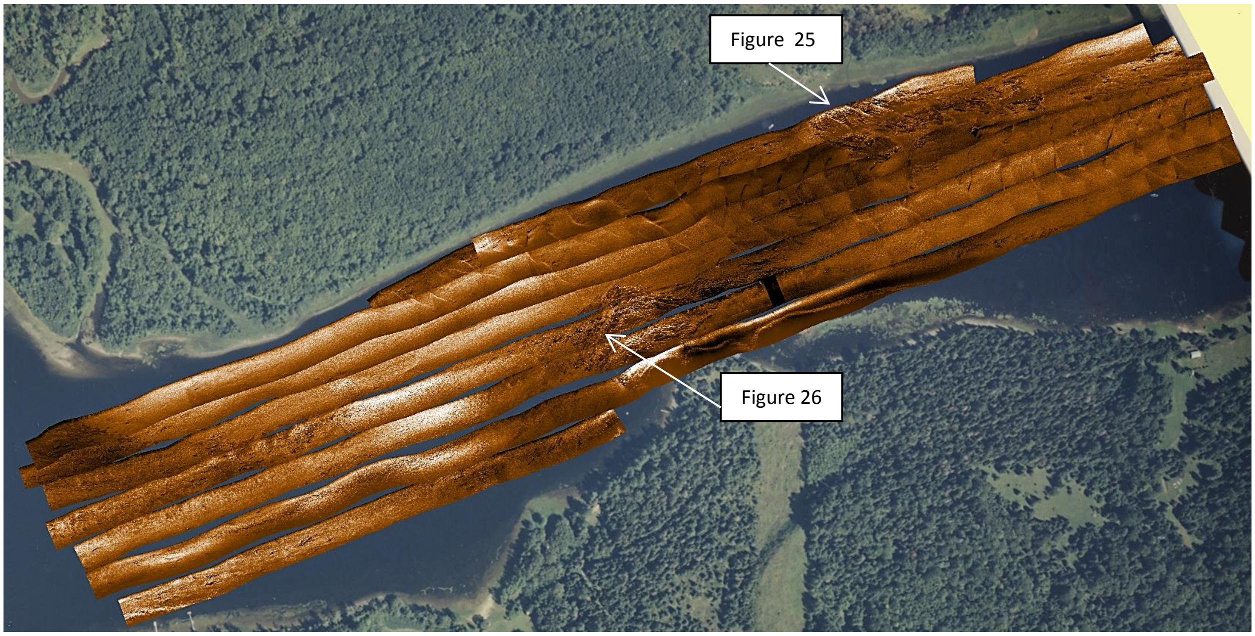

Figure 24. Mosaic of sonar images – viewing toward south – west zone

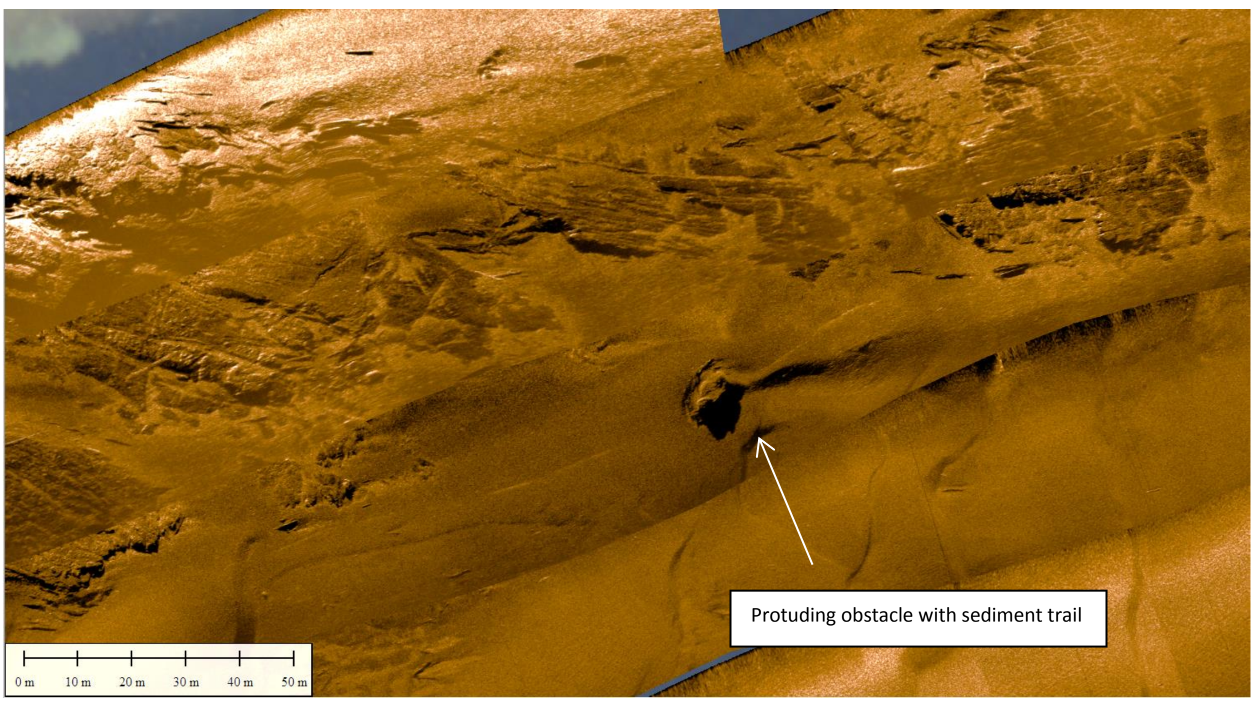

Figure 25. Enlargement of figure 24

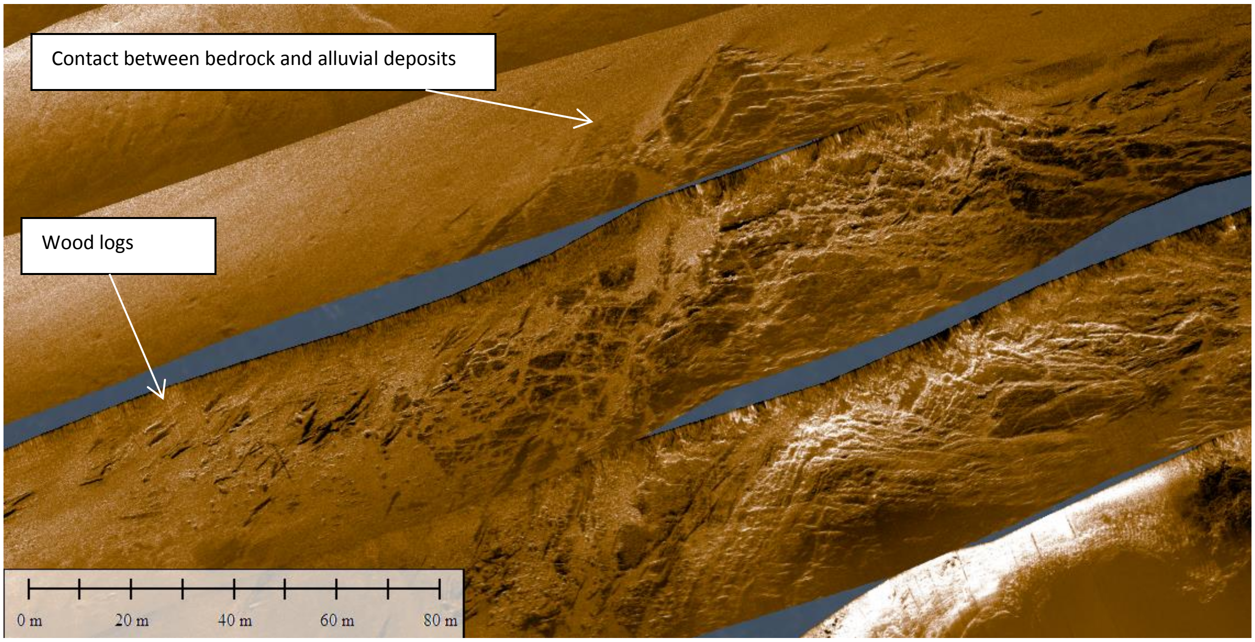

Figure 26. Enlargement of figure 24

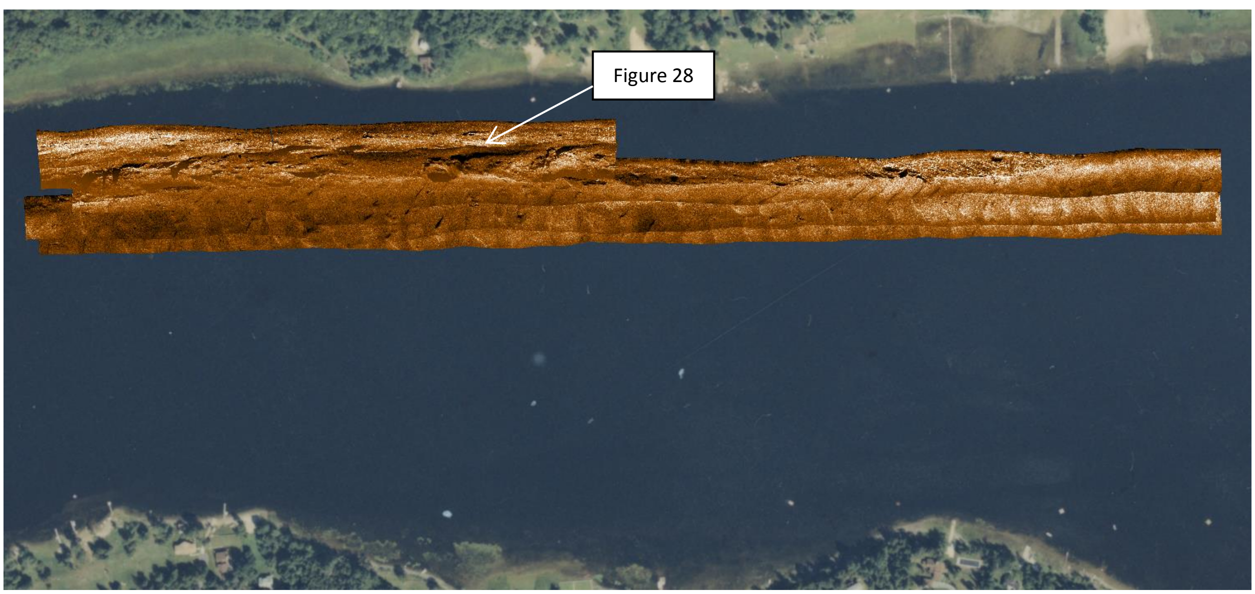

Figure 27. Mosaic of sonar images – viewing toward south – east zone

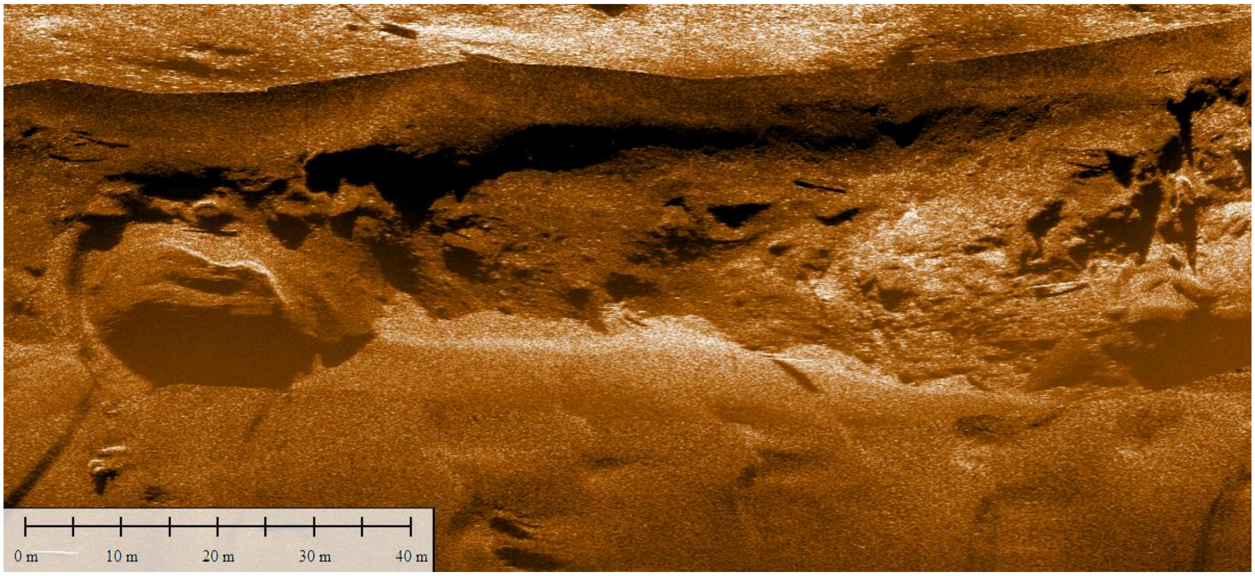

Figure 28. Enlargement of figure 27

In a second case, it was observed that for data acquired across the river (perpendicular to flow direction), the most revealing mosaic was built from images acquired with a downstream viewing orientation. If the survey lines are close enough one to another, these downstream looking images can overlap like shingles. In such cases, it was observed that the mosaic must be built with the most downstream image being underneath, partially covered by the other images upstream. Observations have shown that sonar return is strongly influenced by fluvial dune shadows. The human brain seems to better interpret these shadows when they are viewed from the same orientation (Figures 29-30-30a).

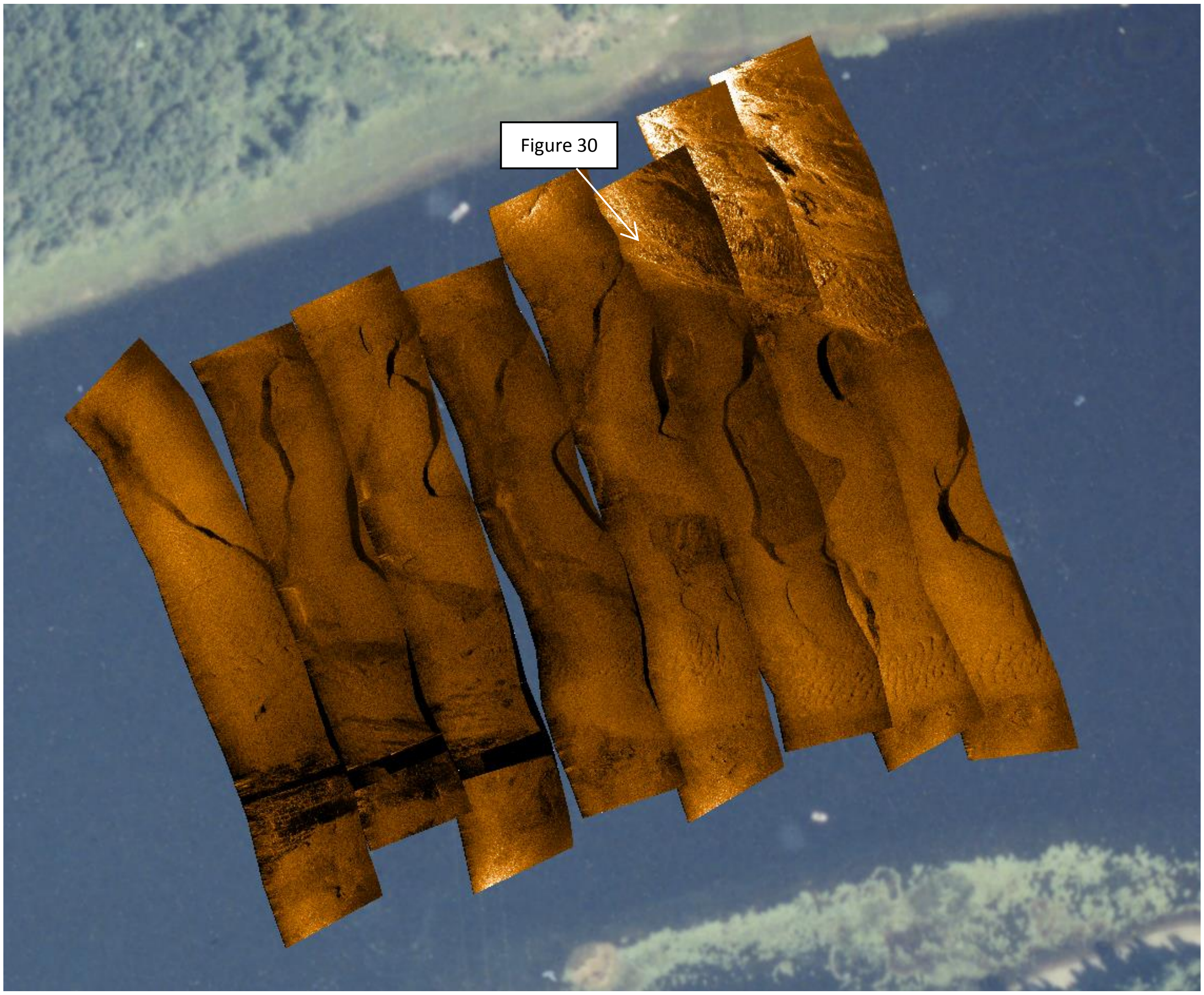

Figure 29. Mosaic of sonar images – viewing toward east (downstream) – west zone

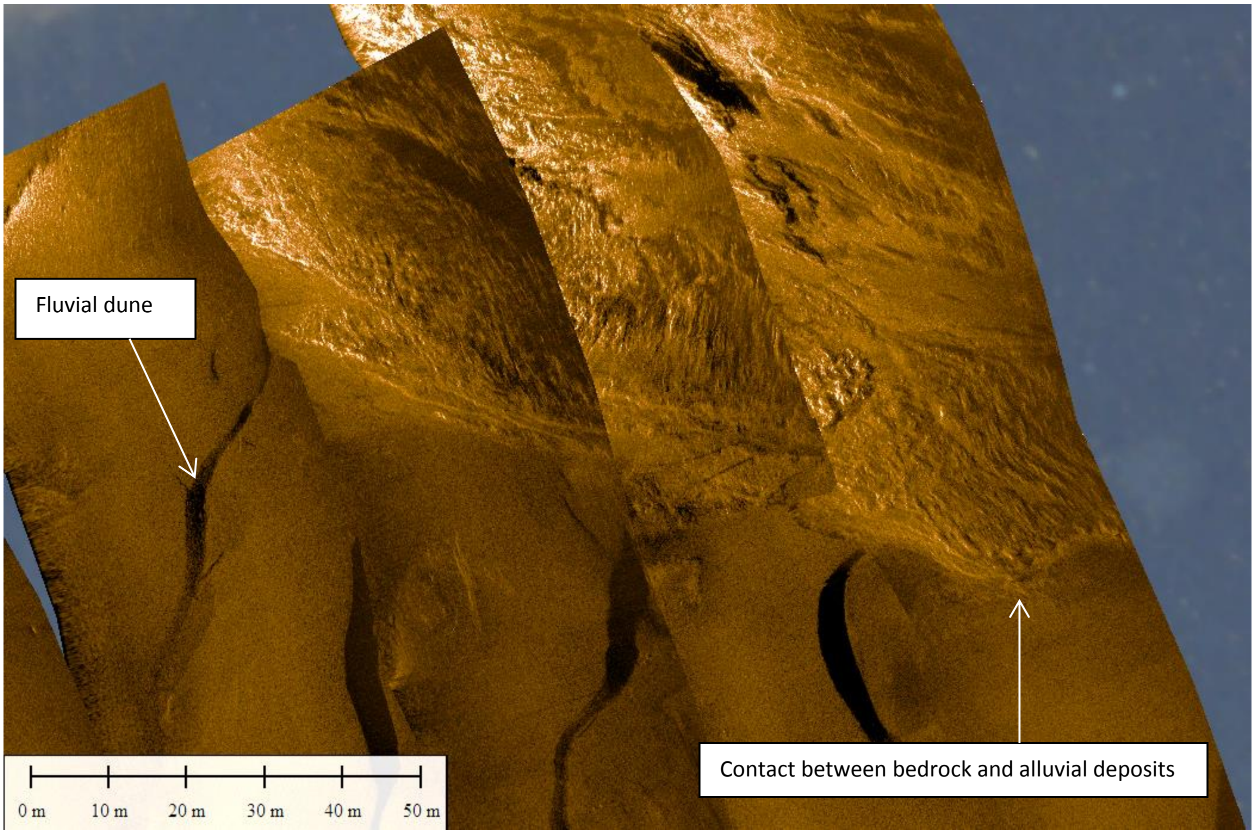

Figure 30. Enlargement of figure 29


Figure 30a. Ripple mark on actual beach

Finally, it was also observed that it is good practice to generate distinct mosaics built from images of different orientation since these products convey different information. (Figures 31 & 32).

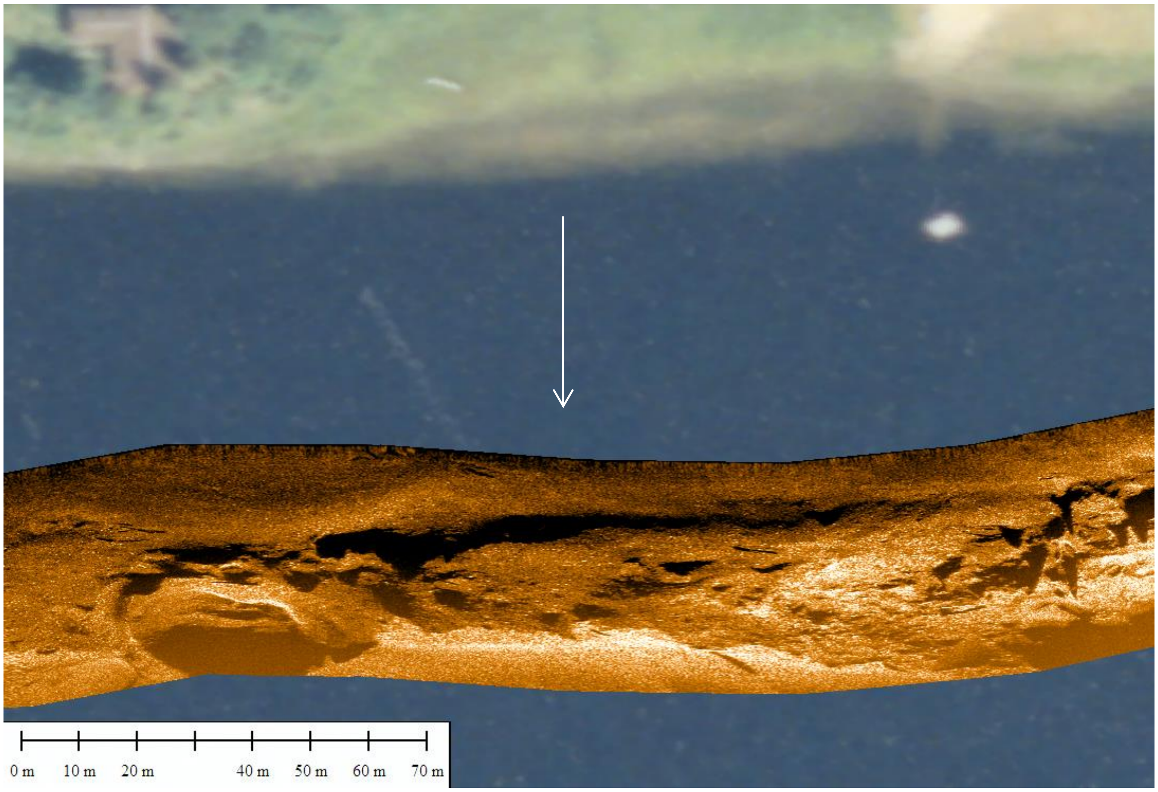

Figure 31. East zone. South viewing orientation

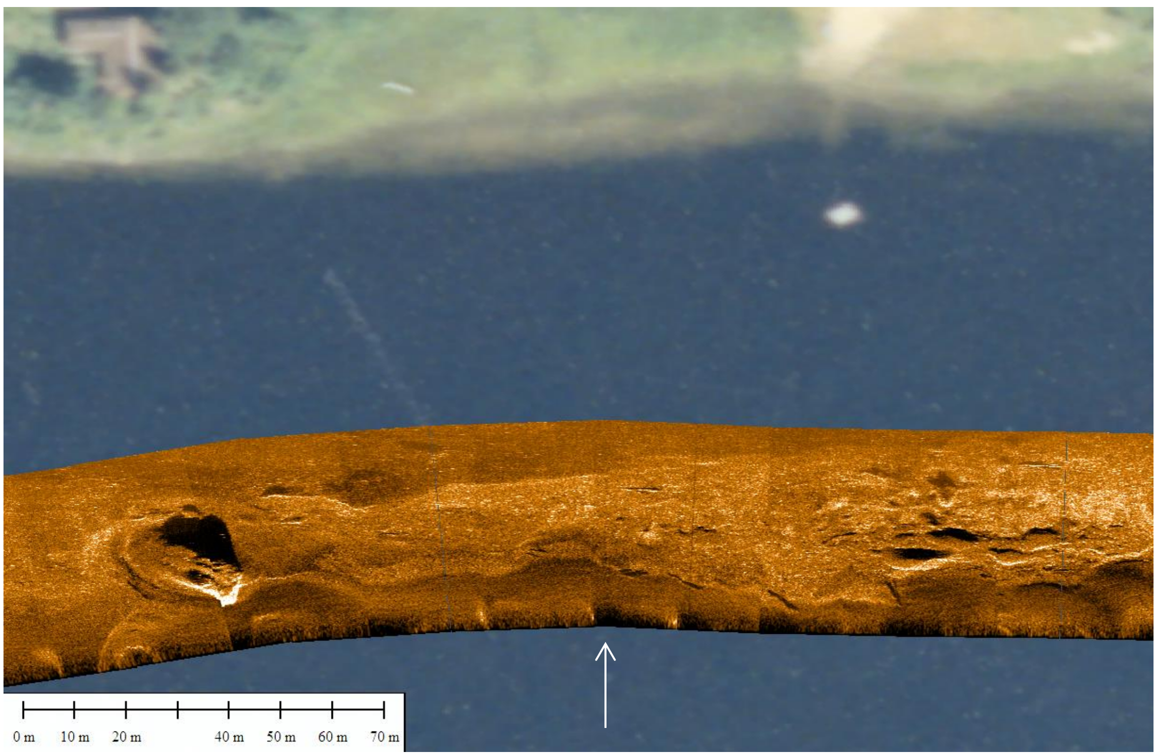

Figure 32. East zone. Same area as above. North viewing orientation.

6.4) Depth profile and bathymetric map

A side scan sonar survey allows the user to acquire, along with sonar images, point depth data at nadir of the transducer (boat) to produce bathymetric maps or water depth profiles across the water body. Figures 33-34 illustrate products which were generated from data acquired by the sonar at Quyon simultaneously and automatically with the side scan survey.

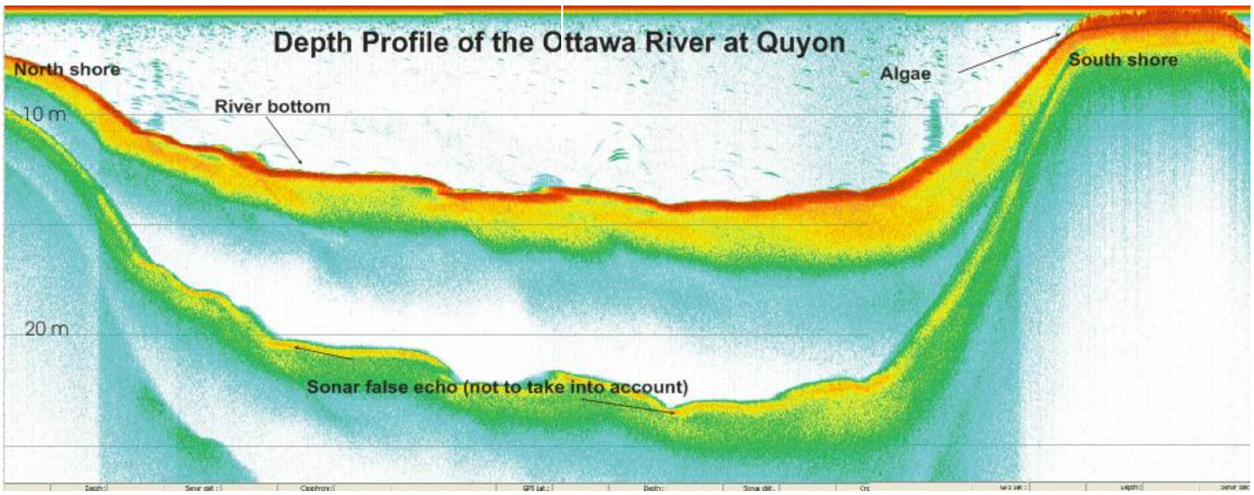

Figure 33. Depth profile of Ottawa River at Quyon

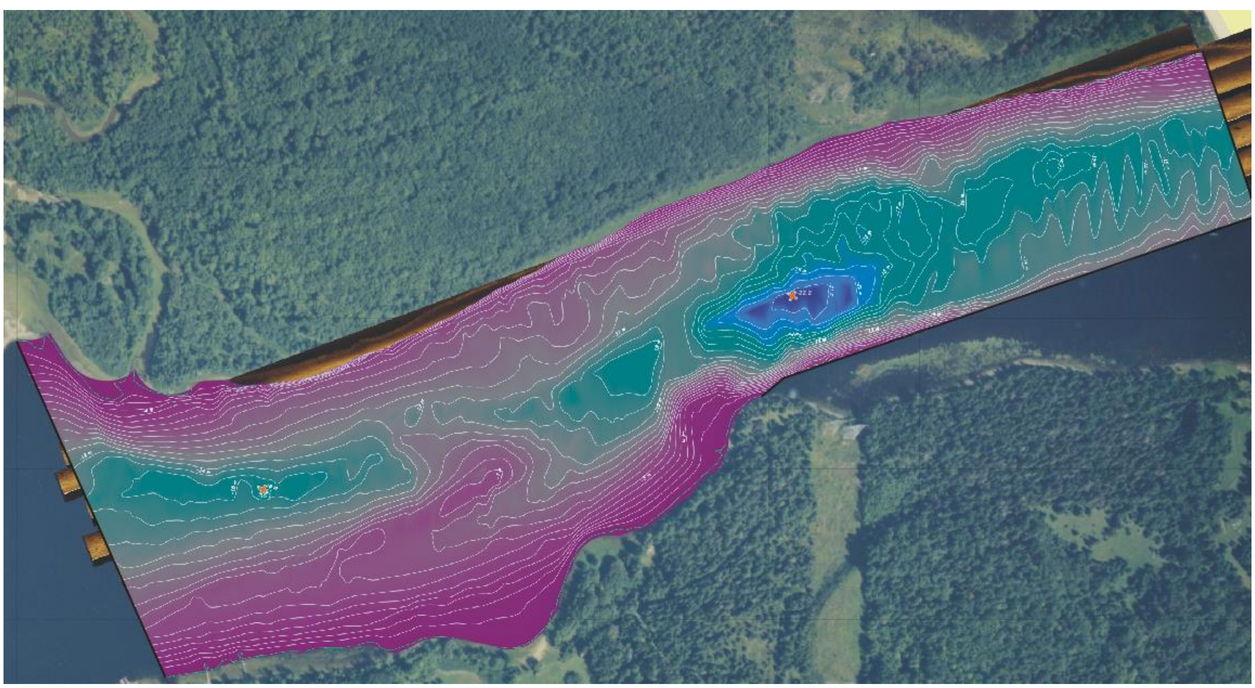

Figure 34. Bathymetric map of Ottawa River at Quyon, overlaid on airphoto.

7) Findings and conclusion

This case study showed the capabilities of consumer grade side scan imaging sonars to provide a detailed view of the floor of a lake, a river, or a sea coastal environment. More specifically, this study has shown their potential for geomorphological mapping: bedrock features, contact between bedrock and surficial deposits, lineaments, fluvial dunes, and various erosional/depositional features.

The imagery produced for Quyon could not determine if remnants of the landslide were still visible on the river floor. However, the imagery allows to better plan the location of very low frequency sonar profilers to analyse deeper sedimentary deposits.

There is a large range of applications for this subsurface imaging technique. Its potential has already been used in a Canadian National Park to locate wood logs, which is considered a hazard for pleasure boating in the Park. This investigation has also shown its potential for coastal fracture/lineaments mapping, especially important in rocky coastal landslide. There is also potential for geomorphological mapping for the planning of underwater infrastructure such as river crossing by buried pipelines. In short, it is possible to envision the adaptation of this technique in other areas, and for other themes, such as geohazards in many locations around the world. This way, imaging sonars may fill a strategic technological gap especially in remote northern areas.

Finally, this study describes the main constraints and guidelines related to the production of a survey and proposes mitigation methods, for geotechnical and geohazard risk investigation.

8) Related publications

This document is a follow-up to an initiative started few years ago. The goal was to utilize consumer grade depth sounders and low cost software to acquire large quantities of water depth points. These depth points were then used to generate a bathymetric model of water bodies, to evaluate the water volume supply of lakes within Nunavut communities. The reader will find below a list of publications related to this topic.

Budkewitsch, P., Prévost, C., Pavlic, G., Pregitzer, M. July 2007. Watershed Mapping and Monitoring for Northern Community Impact Assessment – Iqaluit, Nunavut. Natural Resources Canada. Ottawa. GSC Open File # 6619 & 6750

Budkewitsch, P., Prévost, C., Pavlic, G., Pregitzer, M. August 2007. Watershed Mapping and Monitoring for Northern Community Impact Assessment – Clyde River, Nunavut. Natural Resources Canada. Ottawa. GSC Open File # 6620.

Budkewitsch, P., Prévost, C., Pavlic, G., Pregitzer, M. August 2011. Watershed Mapping and Monitoring for Northern Community Impact Assessment – Cape Dorset, Nunavut. Natural Resources Canada. Ottawa. GSC Open File # 6843 & 6844.

Armstrong, R.,Budkewitsch, P., Prévost, C., Pavlic, G., Pregitzer, M. August 2011. Description of Water Depth Survey Datasets from Rankin Inlet, Nunavut. Natural Resources Canada. Ottawa. GSC Open File # 6751

Budkewitsch, P., Prévost, C., Pavlic, G., Pregitzer, M. August 2013. Description of Watershed Outline and Water Depth Survey Datasets for Whale Cove, Nunavut . Natural Resources Canada. Ottawa. GSC Open File # 6848 & 6847

Budkewitsch, P., Prévost, C., Pavlic, G., Pregitzer, M. August 2013. Description of Fresh Water Assessment Datasets for Arviat, Nunavut. Natural Resources Canada. Ottawa. GSC Open File # 6846 & 6845

9) References and acknowledgements

-A massive sensitive clay landslide, Quyon Valley, southwestern Quebec, Canada, and evidence for a paleoearthquake triggering mechanism. Brooks, G R; Quaternary Research (New York) vol. 80, no. 3, 2013; p. 425-434

http://www.windguru.cz/fr/
http://www.humminbird.com/
http://www.lowrance.com/
http://son2xtf.software.informer.com/
http://humviewer.cm-johansen.dk/
http://www.navicom.fr/telechargements/logiciels-pour-humminbird

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-Mr. Vernon Singhroy, project leader, colleague, engineer/geologist and research scientist in remote sensing applied to geohazards.

-M. Greg Brooks, Project leader, Fluvial geomorphologist, Geological survey of Canada, for his geomorphogical interpretation of Quyon sonar images.

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-Mr. Gaëtan Synnott, of La Mauricie National Park, Parks Canada, for sharing of experience on consumer grade imaging sonars.

-Mrs. Lori White, colleague, who greatly helped with the translation from French to English of this document.

Ce document ''Openfile / Dossier Public '' est aussi disponible en français sous le titre '' Guide de production d'imagerie sonar à l'aide d'outils grand public - Étude de cas à la rivière des Outaouais à Quyon, Québec. Dossier Public # 5

Annex 1

Consumer Grade Side Scan Imaging Sonar Datasets

Acquired on Ottawa River, at Quyon, Québec.

This document contains a list of output files processed for the production of geocoded sonar images, and for the production of mosaïcs of sonar images. These files are available for distribution. Each file is illustrated.

These digital files in geotiff format are available upon request by contacting the author:

Christian Prévost
Canada Centre for Mapping and Earth Observation
Earth Sciences Sector
Natural Resources Canada
560 Rochester, 6e floor, Ottawa, Ont. K1A 0E4

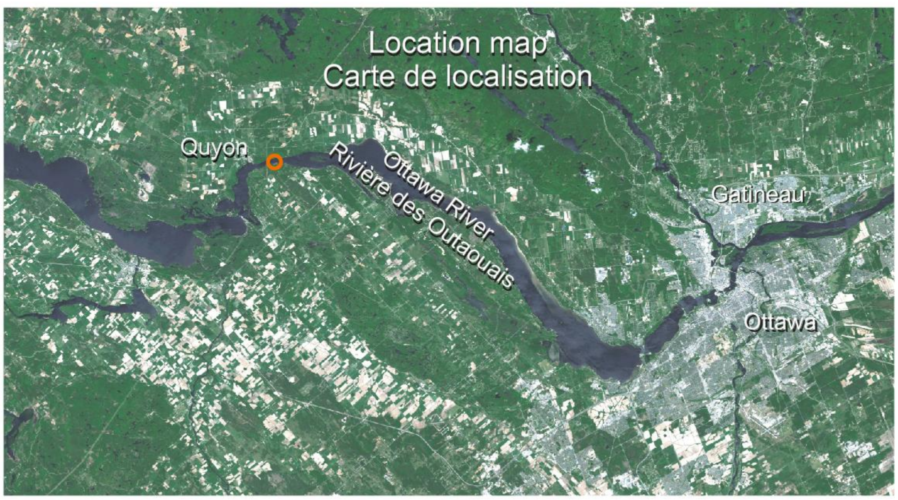

Figure A1-1. Location map

Figure A1-2. Location map

Figure A1-3. Quyon site. Sonar survey plan overlaid on airphoto.

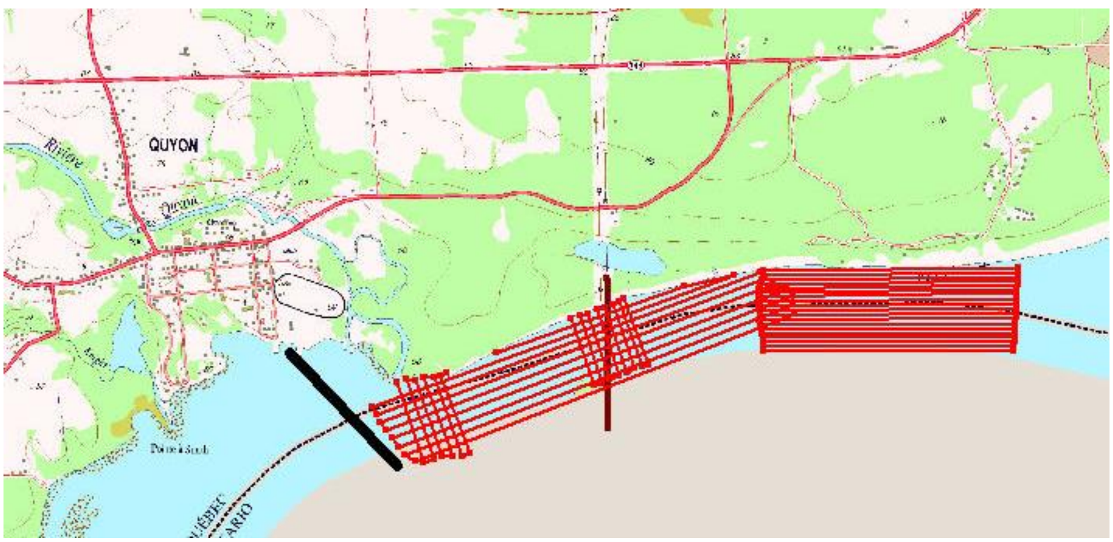

Figure A1-4. Quyon site. Sonar survey plan overlaid on 1:20,000 topo map.

Figure A1-5. Quyon site. Sonar survey as executed.

The consumer grade side scan imaging sonar survey at Quyon is made of survey lines of various length, and acquired from various orientations. The sequence starts at line #71 and ends at line #92. There is no #88 line.

Lines 71 to 79 were acquired in parallel, navigating **upstream and downstream** in the **western** zone of the survey site.

Lines 80-81were acquired **across** the river, in the **western** zone of the survey site.

Lines 82-83-86-87-89 were acquired in parallel, navigating **upstream and downstream** in the **eastern** zone of the survey site.

Lines 84-85 were acquired **across** the river, in the most **eastern** zone of the survey site.

Lines 90-92 were acquired **across** the river, in the most **western** zone of the survey site.

Sonar files are huge. Their original resolution after processing is 19 mm. Therefore, in most cases, there is a resampled version at 100 mm (.1m).

Figure A1-6. Quyon site. Example of lines 71 to 79 overlaid on airphoto.

-Background image for the western part

> sonar>Photo aérienne 15K > Partie ouest.tif

UTM, 24 bits, 9750 pixels, 4850 lines, 0.2 metre, 138 megs.

Figure A1-7.

-Background image for eastern part

> sonar> Photo aérienne 15K > Partie est.tif

UTM, 24 bits, 9750 pixels, 4850 lines, 0.2 metre, 138 megs.

Figure A1-8.

-Lines 79-78-71-72-73-74-75-76-77

Lines east-west of the western part – view toward north

Files for distribution

> sonar>Lignes 71-79>visee_ nord.tif
18668 pixels x 10304 lines x 4 bands, 100 mm, 751 megs

Figure A1-9.

Lines east-west of the western part – view toward south

> sonar>lignes 71-79>visee_sud.tif
16622 pixels x 8216 lines x 4 bands, 100 mm,   533 megs

Figure A1-10. **This view, toward the south, represents the best product for visualization. This south viewing mosaic conveys the maximum of information with regards to images acquired parallel to the river flow.**

-Lines 80-81

Lines across the river, in the western part, viewing toward upstream

Files for distribution

>sonar>Lignes 80-81>visee vers amont-19 mm.tif

19166 pixels, 19936 lines, 4 bands, 19 mm resolution, 1.5 gigabytes

There is also a version resampled at 100mm :

> sonar>lignes 80-81>visee vers amont-100 mm.tif

3683 pixels, 3831 lines, 4 bands, 100 mm resolution, 55 megabytes

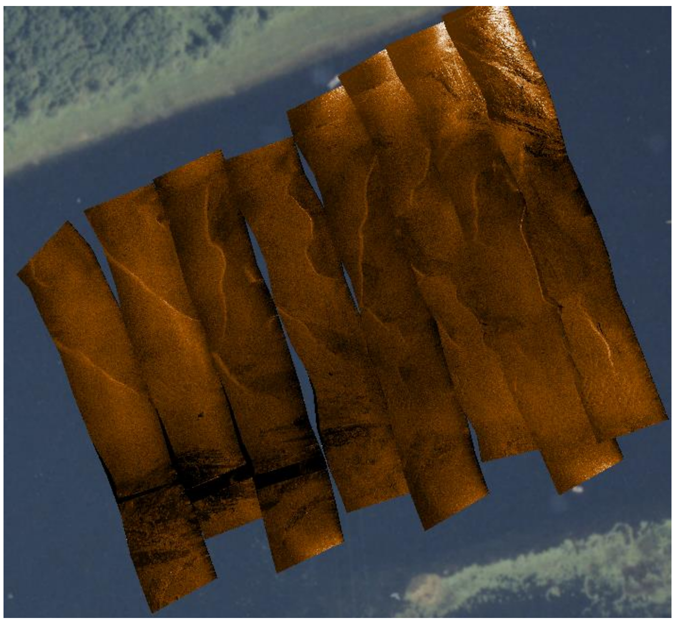

Figure A1-11

Lines across the river, in the western part, viewing toward downstream.

>sonar>Lignes 80-81> visee vers aval-19 mm.tif
19169 pixels, 17225 lines, 4 bands, 19 mm resolution, 1.3 gigabytes

There is also a version resampled at 100mm :
>sonar>Ligne 80-81>visee vers aval-100 mm.tif
3683 pixels, 3309 lines, 4 bands, 100 mm resolution, 47 megabytes

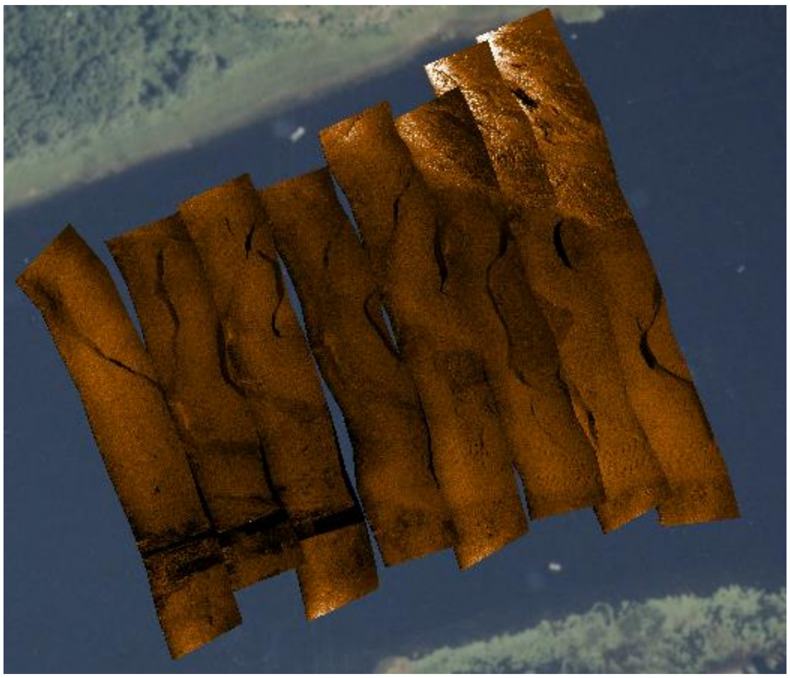

Figure A1-12. **Lines 80-81 viewing toward downstream. Best product for lines 80-81. This downstream viewing conveys the maximum of information with regards to images acquired across the river.**

-Lines 82-83-86-87-89

Lines east-west of the eastern part – view toward south

Files for distribution

> sonar>Lignes 82-83-86-87-89>Visee sud-19mm.tif

58131 pixels, 7616 lines, 4 bands, 19 mm resolution, 1.7 gigabytes

There is also a version resampled at 100mm :

> sonar>Lignes 82-83-86-87-89> Visée sud-100mm.tif

11143 pixels, 1460 lines, 4 bands, 100 mm resolution,   56 megabytes

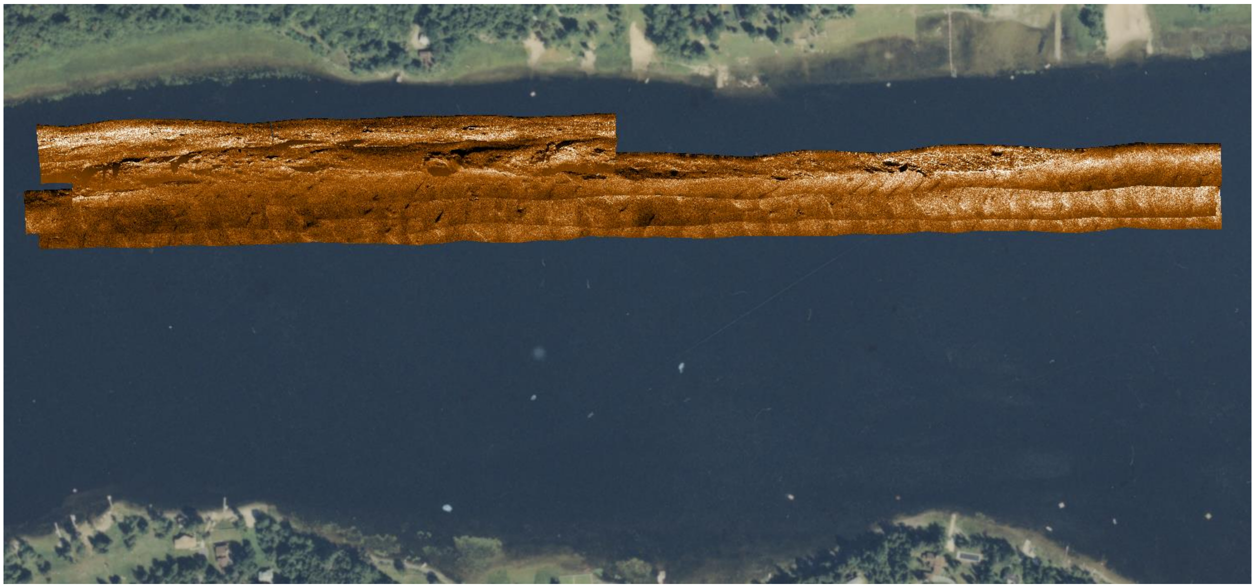

Figure A1-13. **This view, toward the south, represents the best product for visualization.**

Lines east-west of the eastern part – view toward north

> sonar>Lignes 82-83-86-87-89>visee_ nord-19mm.tif
62218 pixels, 10094 lines, 4 bands, 19 mm resolution, 2.4 gigabytes

There is also a version resampled at 100mm :
> sonar>Lignes 82-83-86-87-89>visee_nord-100mm.tif
11938 pixels, 1937 lines, 4 bands, 100 mm resolution, 90 megabytes

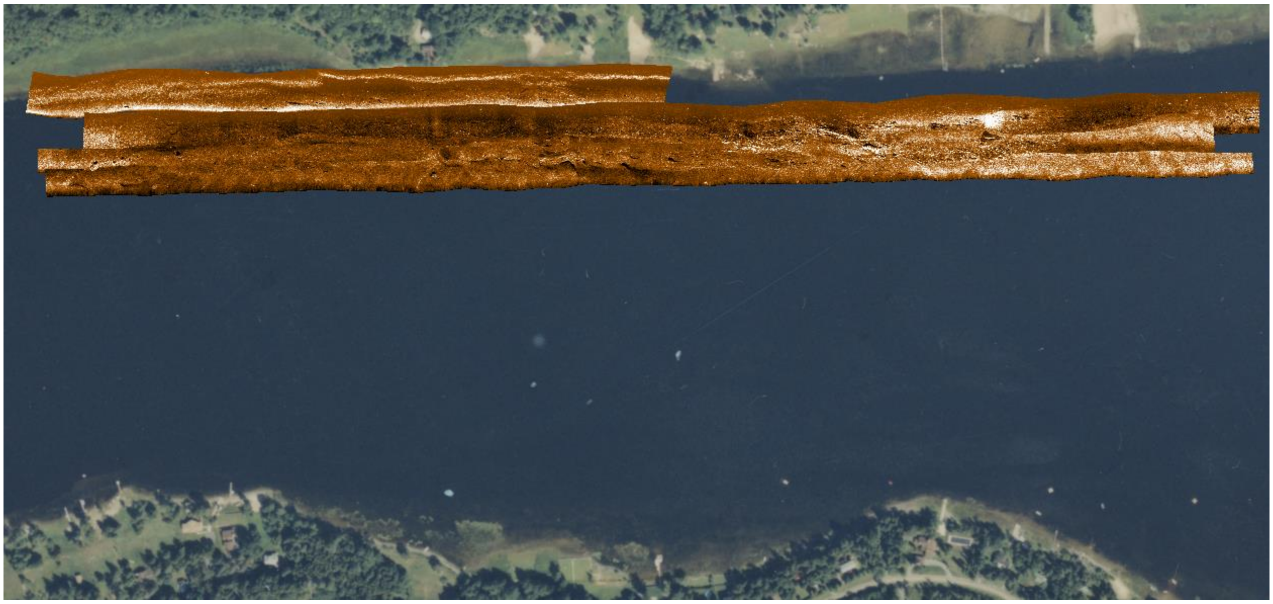

Figure A1-14.

-Lines 84-85

Lines across the river, in the most eastern part, viewing toward downstream.

Files for distribution

sonar> Ligne 84-85> visee_ aval_19 mm.tif

8904 pixels, 23749 lines, 4 bands, 19 mm resolution, 825 megs,

There is also a version resampled at 100mm :

sonar> Ligne 84-85> visee_ aval_100 mm.tif

1709 pixels, 4558 lines, 4 bands, 100 mm resolution, 29 megs,

Figure A1-15. **This viewing toward downstream is the best product for visualization.**

Lines across the river, in the most eastern part, viewing toward upstream.

sonar > Ligne 84-85> visée_amont-19mm.tif

9409 pixels, 25513 lines, 4 bands, 19mm resolution

There is also a version resampled at 100mm :

Sonar>> Ligne 84-85> visée_amont-100 mm.tif

1805 pixels, 4894 lines, 4 bands, 100 mm resolution, 34 megabytes

Figure A1-16.

-Lines 90-91-92

Lines across the river, in the most western part, viewing toward upstream.

Files for distribution

Sonar>lignes 90-91-92> visee- amont-19 mm.tif

18067 pixels, 17162 lines, 4 bands, 19 mm resolution, 1.2 gigabytes

There is also a version resampled at 100mm :

sonar> lignes 90-91-92> visee- amont-100 mm.tif

3471 pixels, 3297 lines, 4 bands, 19 mm resolution, 44 megabytes

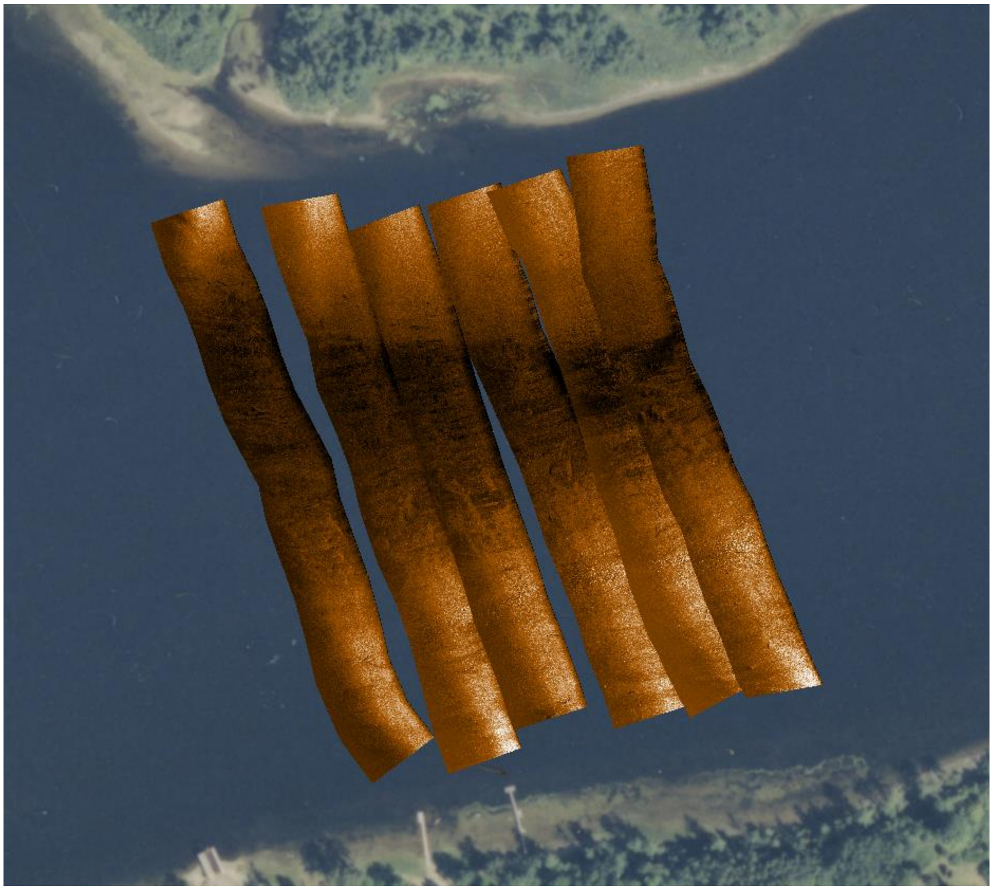

Figure A1-17

Lines across the river, in the most western part, viewing toward downstream.

sonar> Lignes 90-91-92> visee-aval-19 mm.tif
18215 pixels, 17439 lines, 4 bands, 19 mm resolution, 1.2 gigabytes

There is also a version resampled at 100mm :
sonar> Lignes 90-91-92> visee-aval- 100 mm.tif
3496 pixels, 3347 lines, 4 bands, 19 mm resolution, 45 megabytes

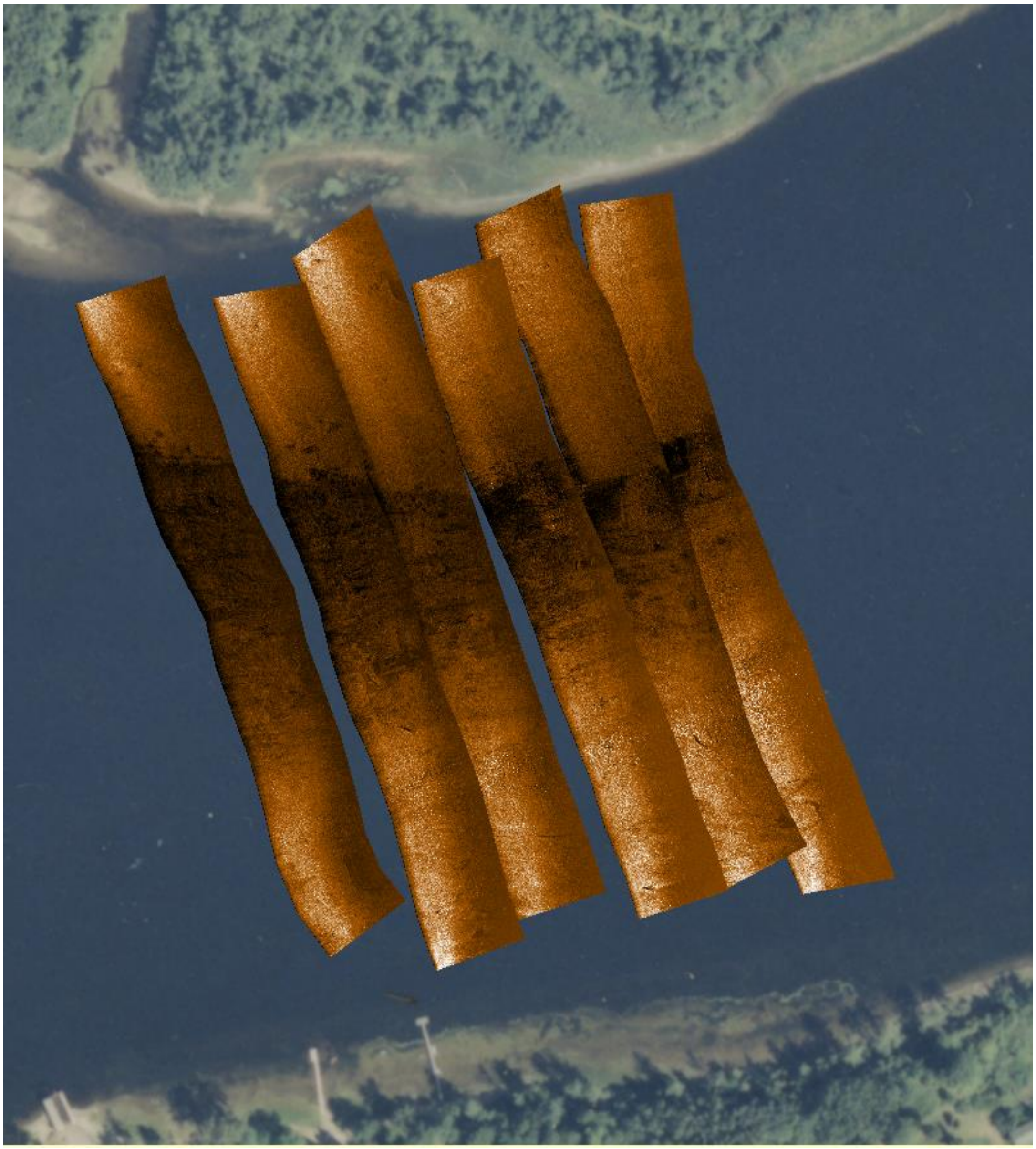

Figure A1-18

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