

# Mackenzie River 2D Seismic State of the Art Data Acquisition with Environmental Sensitivity

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## ABSTRACT

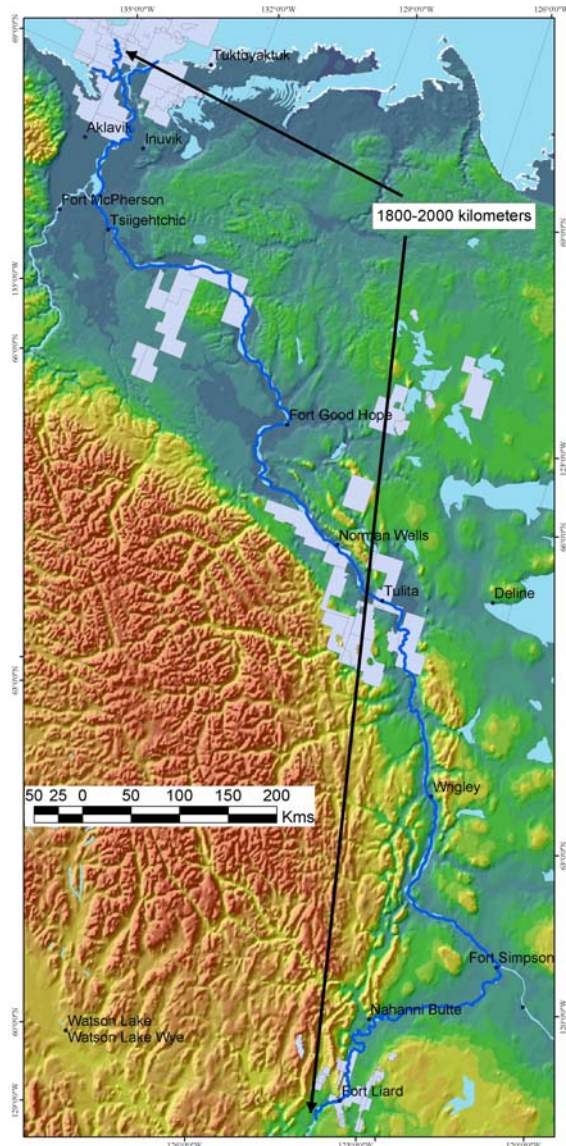
### Introduction

This presentation will chronicle the results of the acoustic study, a synopsis of the environmental study with regards to this acquisition technique, an overview of the acquisition issues and challenges, and the resultant seismic product from 2002 with an outline of the ultimate goal line of seismic coverage from the Mackenzie Delta to the British Columbia border.

### Summary

Early in the summer of 2001, WG turned to the Northwest Territories and in particular the Mackenzie Valley as an area for regional seismic exploration. The idea was brought forward to use the Mackenzie River, the 10th largest river in the world, as a vehicle to provide a state of the art regional seismic survey to the Mackenzie Valley. One of the main accomplishments would be to tie major basins of the Northwest Territories together through a relatively continuous regional line. In some cases, the seismic available was inconsistent and incomplete.

By the summer of 2002 when the actual survey was undertaken a myriad of challenges had been acknowledged and met. These challenges ranged from those dealing with the National Energy Board to the various Regulatory agencies. Added to this were the purely operational ones such as water depths and submerged and floating debris. Never to be overlooked were the geophysical issues. This included all seismic source considerations and



the best approach to collect the data along at times a winding river channel. The resultant data from 2002 was a superior product due to high fold and enhanced coupling into the ground. And lastly would be the environmental concerns with this type of acquisition configuration on the Mackenzie River.

### Acquisition Parameters

Vessel	NTCL River Ship
Streamer	Sentry Solid
Streamer Length	2000 to 2600 meters
Streamer Depth	3-5 meters
Group Interval	12.5 meters
Source Depth	3-5 meters
SP Spacing	6.25 meters
Source	1500 cubic inches, 37.9 bar meters
Fold	160 (fold may be reduced in some areas river geometry or conditions)
Record Length	5-7 seconds
Sample Rate	2 milliseconds
Recording Filter	Low Cut 2 Hz @ 6dB Octave slope
High Cut	206 Hz @ 3db Octave slope

### Total potential program:

1800 to 1500 kilometers

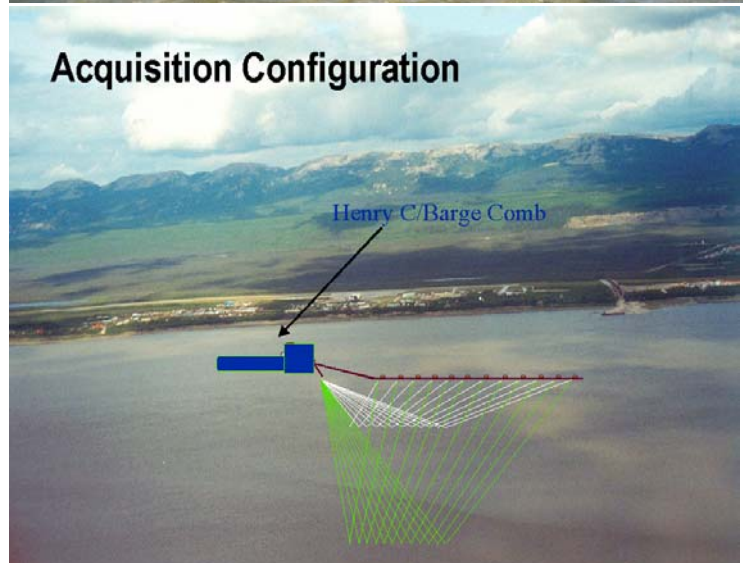
800 kilometers with a 2.4 to 2.6 kilometer cable.

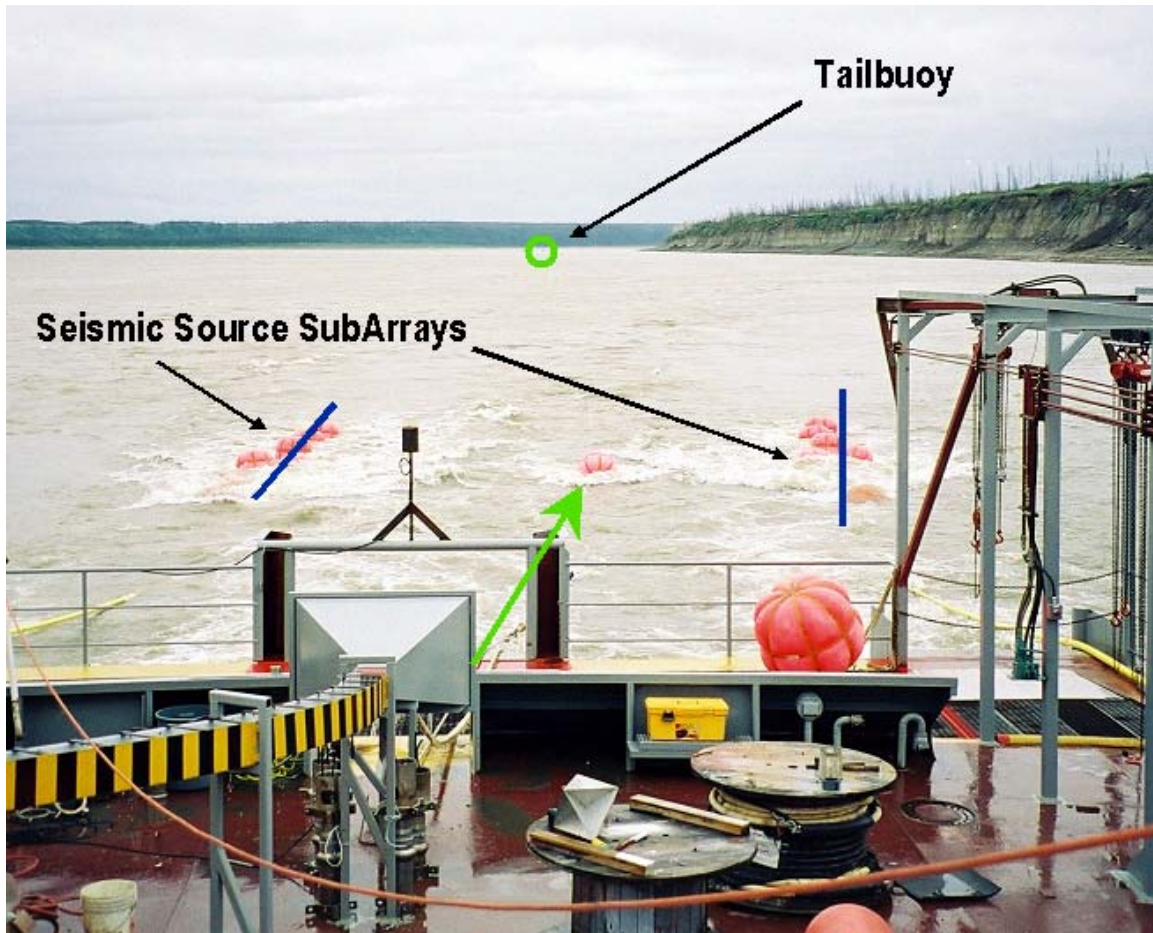
500 kilometers with a 2 kilometer cable.

200 to 500 kilometers with a 1.6 kilometer cable.

Total program acquisition time: 60-75 days after production start-up

Possible program constraints: water depth, environmental conditions, river current, floating/submerged debris





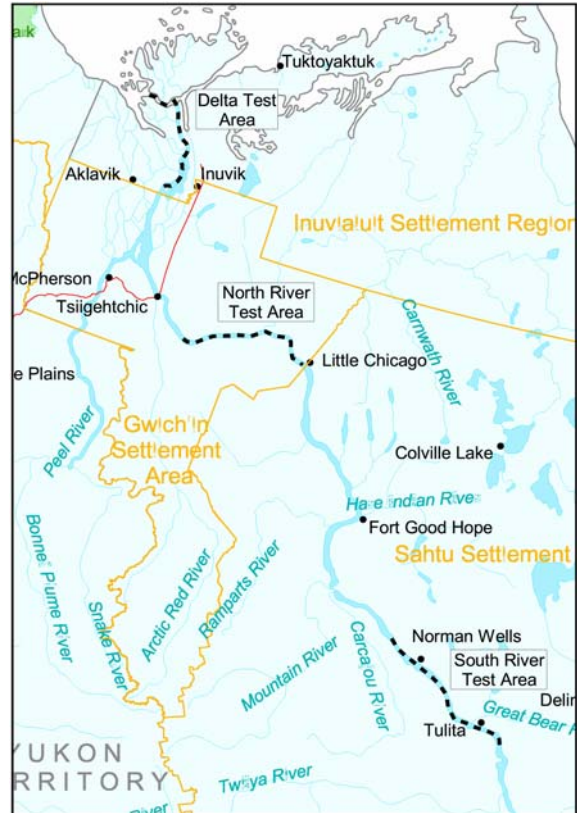
## I. Acoustic Monitoring, Summer 2002 Results

- Measure acoustic source levels of WesternGeco's airgun array system.
- Measure the variation of amplitude with direction and distance from the airgun arrays.
- Measure acoustic levels at fish cage locations during exposure tests
- Measure noises produced by the vessels themselves.
- Investigate how well sound propagates to long ranges up and down the river.
- Measure sound levels and spectra of noise propagating into tributaries that flow into the Mackenzie.

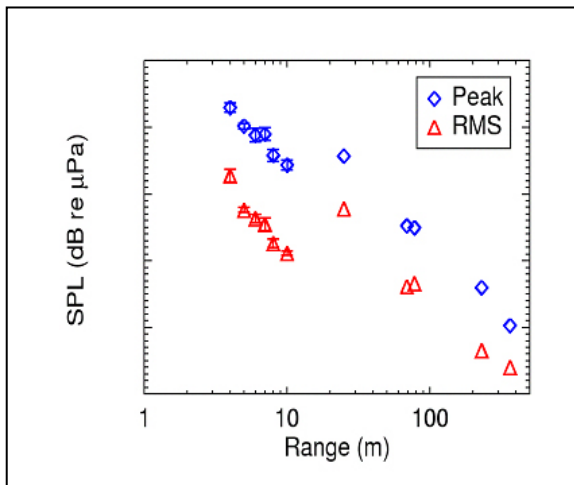
## Locations

- South River Test Area  
1 to 2 km wide (variable)  
Channel 4 to 11 m deep  
Shallow slope near shore
- North River Test Area  
2 km wide  
Channel 5 to 20 m deep  
Large sandbar < 3m deep
- Delta Test Area  
Main channel 700m to 1 km wide  
Depth 15-20 m with steep sides.

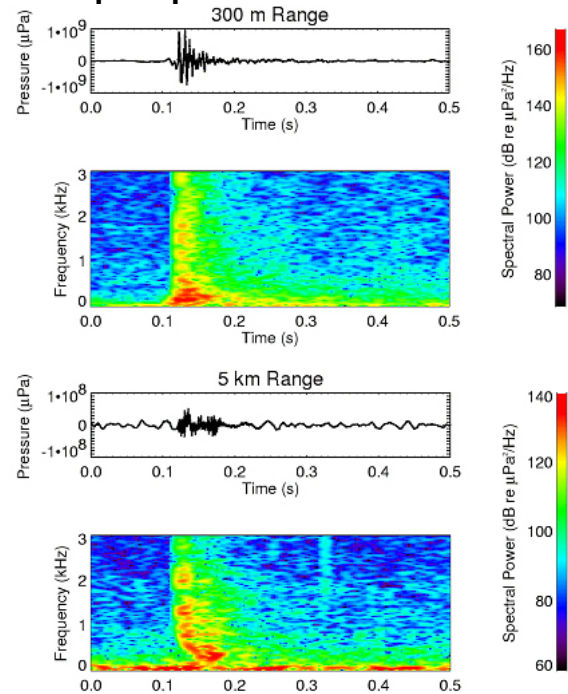
The test areas were selected to ensure that different river conditions were sampled (width, depth, substrate).

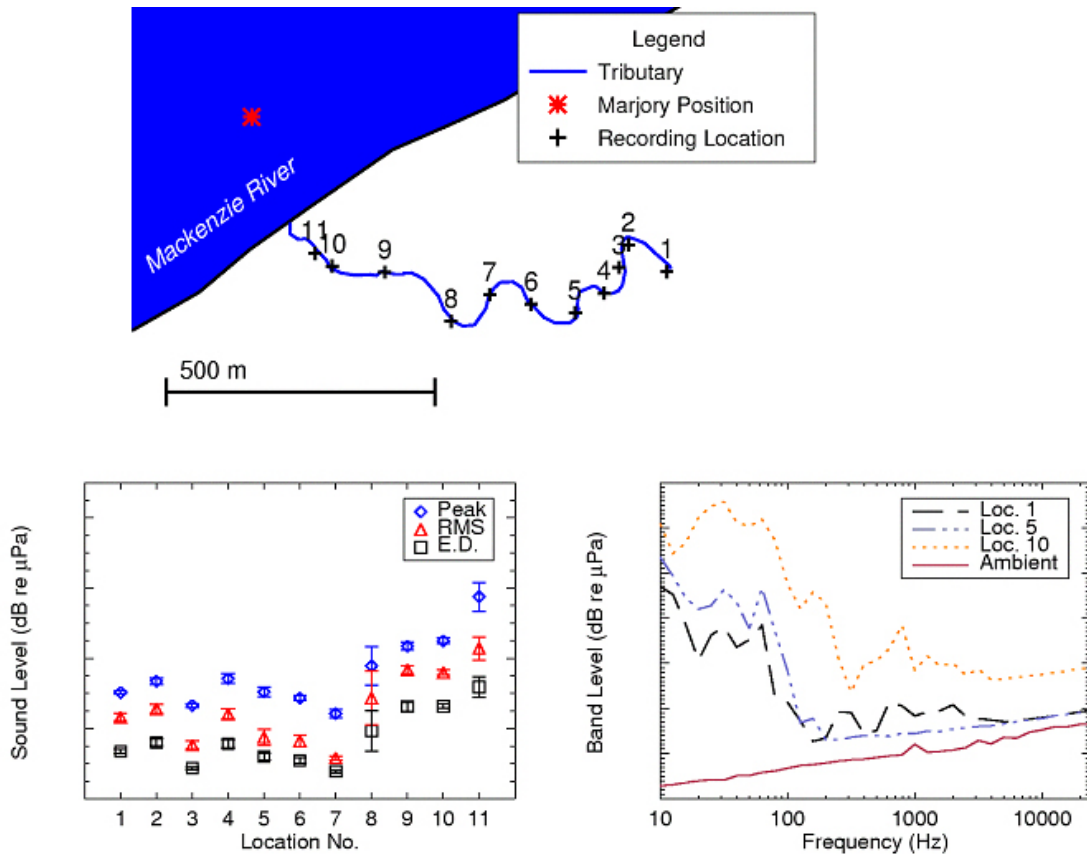


## Example Source Levels



## Example Spectral Content





## II. Fishery Study, Summer of 2002

- Monitor fish distributions in response to airguns
- Monitor fish movements in response to ramping up procedures
- Determine acute effects of airguns on fish species endemic to the Mackenzie River
  - Test areas the same as the acoustic test above.
  - Again, the test areas were selected to ensure that different river conditions were sampled (width, depth, substrate).

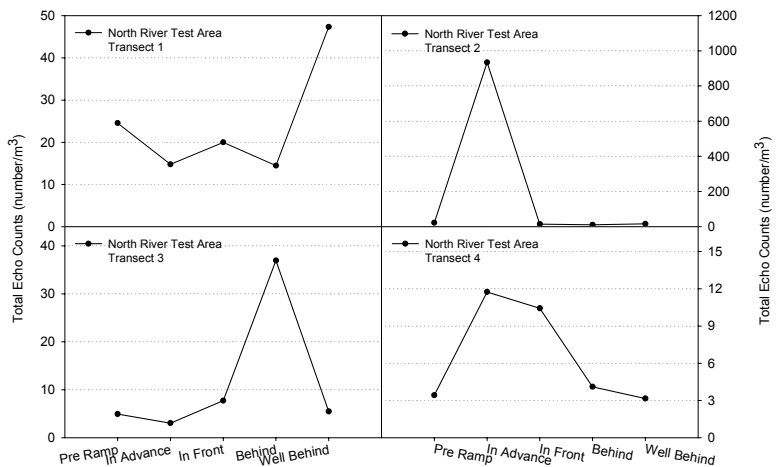
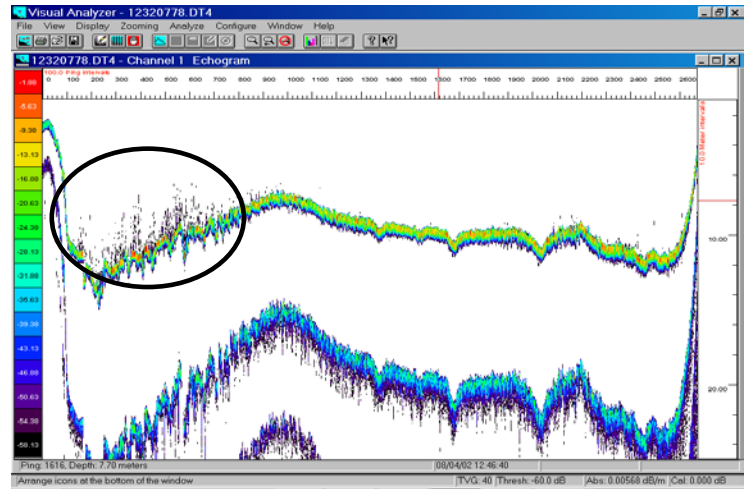
### Three Tests

- Vertical Acoustic Monitoring
  - Monitor fish distributions in response airguns
  - Determine if there is any “fish herding”
  - Four transects with different, bottom profiles, channel widths
  - Transects established at right angles to the path of the seismic vessels.
  - Data was collected from bank to bank or from the closest point to each bank that could be accessed.

- Horizontal Scanning
  - Monitor fish movements in response to ramping up procedures (i.e. determine fish response to acoustical energy from the air guns.)
  - Seismic vessel was stationary
  - Airguns silent and ramping-up / firing
  - Ramp-up = 5 minutes
  - Firing = 1 minute at full capacity

- Caged Fish Test
  - Determine acute effects of airguns on fish species endemic to the Mackenzie River
  - Source levels were measured at various distances to determine exposure levels

Example data (BioSonics® 120 KHz split beam transducer, Visual Analyzer 4.0)

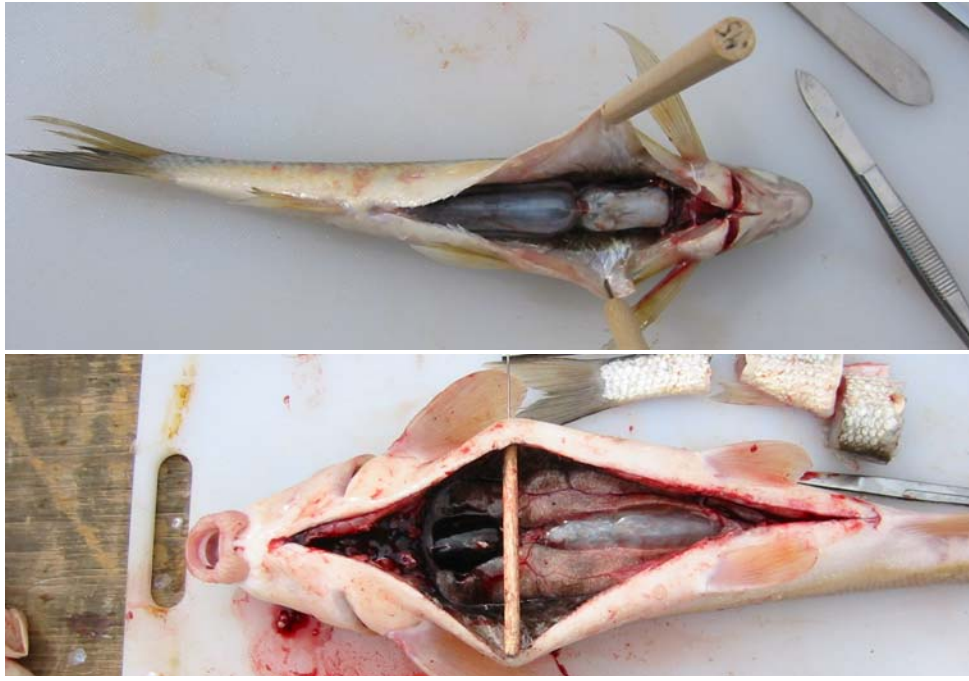


- Small and large bodied fish (total of 196 fish)
  - Small Bodied = pearl dace, juvenile longnose sucker, slimy sculpin, juvenile northern pike, trout-perch
  - Large Bodied = flathead chub, longnose sucker, northern pike, burbot, walleye
- Four Locations
- 2 meters, 85 meters, 446 meters

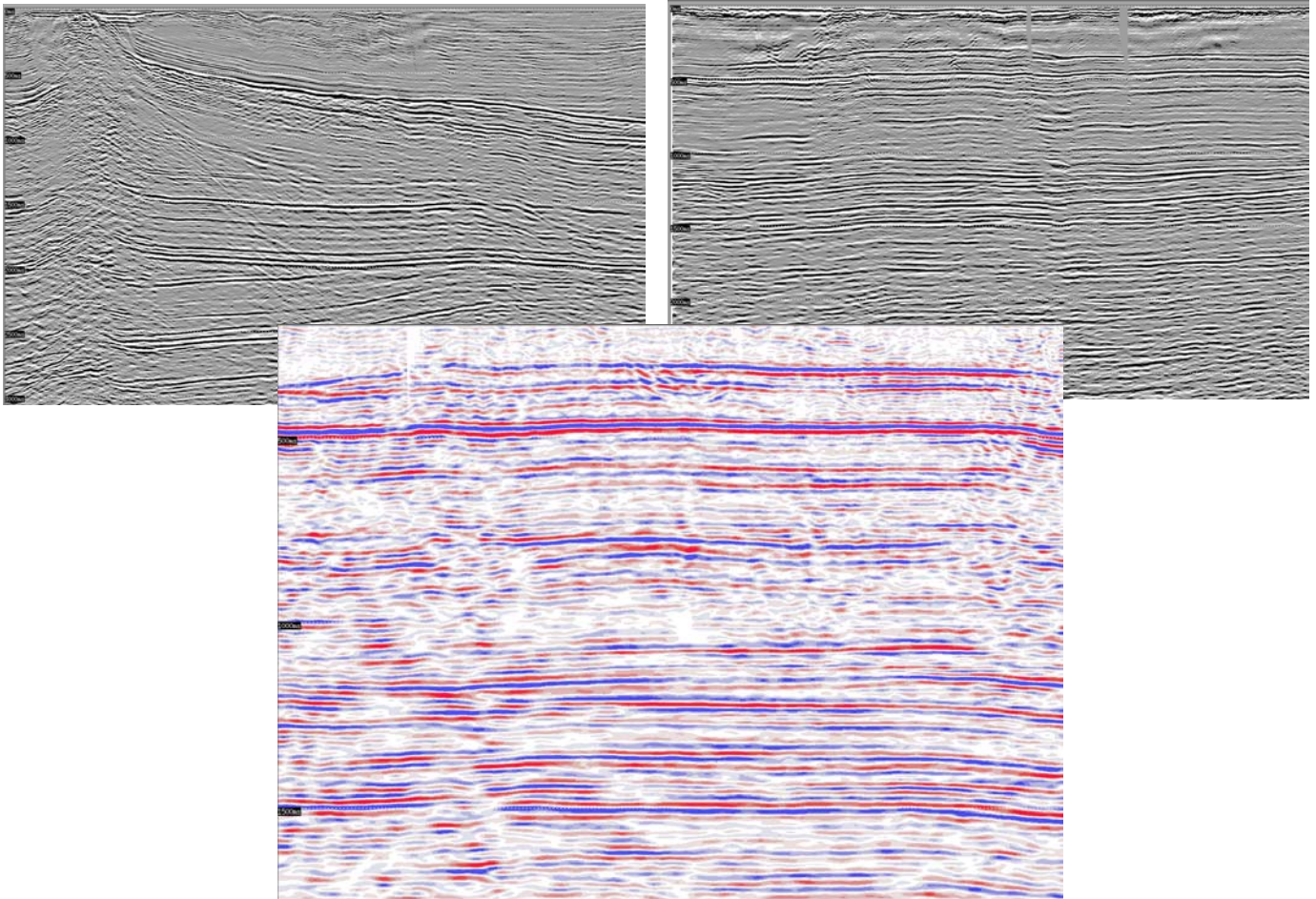


- Fish held for 48 hours after exposure
- Observations at 0.5, 2, 4, 8 and 48 hr post exposure
- 3 fish from each exposure of each trial sacrificed and preserved for histopathological analysis

**Intact swim bladder from fish that were exposed to the air guns**



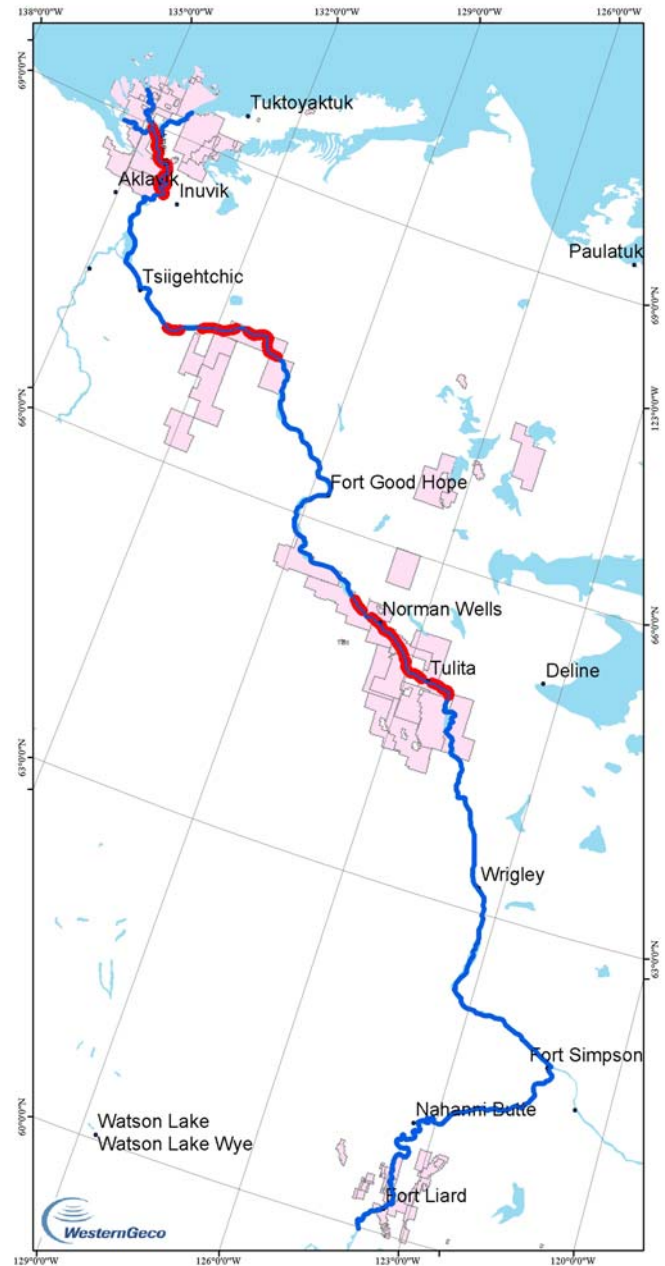
**III. Data from the Summer 2002**





## IV. 2002, Going Forward

The area outline in red was acquired in 2002, the rest of the program will be acquired in the following year.



## Acknowledgments

WesternGeco wishes to acknowledge the expertise and hard work that Golder Associates and Jasco Research Ltd. provided to the project.