

WesternGeco Mackenzie River 2D Seismic Program Proposal

June 13 2002
Copper Room
Yellowknife Inn



EIA - REPORTING

- Delta Seismic Project Description - April 2002
- Mackenzie River Seismic EIA - April 2002
- Revised Delta Seismic Project Description - June 2002
- Response to NEB Mackenzie River IRs. - June 2002
- This meeting: original impact analyses and IR responses



EIA - POTENTIAL INTERACTIONS MATRIX

Matrix to Identify Potential Interactions, WesternGeco 2002 Seismic Project

VIC	Vessel Operations	Disturbance from Vessels (Emissions, noise and wake)	Alaskan Seismic	Disturbance from Reconnaissance Flight
Air Quality		X		
Water Quality	X			
Fish		X	X	
Fish Eggs and Larvae		X	X	
Waterfowl		X	X	X
Raptors		X	X	X
Marine Mammals		X	X	
Beaver		X	X	X
Moose		X	X	
Birds and Recreational Traffic	X	X	X	
Fish Harvesting	X	X	X	



EIA - POTENTIAL PHYSICAL IMPACTS TO FISH

- Adult physical impacts - < 2 m
 - Mitigation - ramping up, movement away
- Eggs, larvae, juvenile physical impacts - < 5 m
 - Mitigation - location and timing
- Hearing - continuous > 180 dB (30 m)
 - Mitigation - ramping up, movement away
 - Mitigation - proposed test program

EIA - POTENTIAL BEHAVIOURAL EFFECTS ON FISH

- Avoidance - at 160 dB (100 m), or greater distance
 - Mitigation: proposed test program
- Migration disruption
 - Mitigation - avoidance and direction of travel
 - Mitigation - "Rest" periods at least 1 hr per 6 hr average
- Herding fish
 - Mitigation - avoidance and direction of travel
 - Mitigation - "Rest" periods at least 1 hr per 6 hr average
- Impaired fishing success
 - Literature review and proposed test program

PRE-PROJECT TEST MONITORING

- Field quantification of air gun noise levels
- Effects of noise on fish and aquatic mammals
- Two 100 - 150 km test sections (River and Delta)
- Continuation of project dependent on results

NEXT STEPS

- Finalising test program protocol with DFO, FJMC, RWED
- Results required to allow project to proceed
- Permitting the test program
- Schedule, logistics, observers
- Analysis and results review process

Draft - Proposed Acoustic and Biological Assessment Program

1.0 Introduction

WesternGeco has reviewed the comments from the various regulatory agencies and summarized by the NEB. WesternGeco understands the concerns raised over uncertainty of the potential effects of the Project, as it relates to completion within a riverine system. WesternGeco also understands and appreciates the importance of the Mackenzie River and the Delta, as it relates to environmental diversity, traditional land use, and spiritual concerns. However, WesternGeco is also confident that the Project, as proposed, will result in minimal disturbance. This is primarily related to the advances in technology, WesternGeco's experience with the technology and the north, and the pro-active mitigation strategies that have been proposed. As such, WesternGeco is proposing a draft monitoring program, that will be finalized through discussions with DFO, FJMC and RWED. Further, it is understood that this program will require scientific collection permits from DFO and the Aurora Research Institute.

Part of the mitigation strategy is to complete a monitoring program. The following section outlines the monitoring program as a five component approach. These five components are:

- a) Acoustic monitoring;
- b) Fish effects assessment (i.e., behavioural);
- c) Aquatic mammal monitoring;
- d) Mortality monitoring; and
- e) Mitigation.

The proposed four component monitoring program is intended to provide information related to air gun seismic sound characteristics and environmental effects within a riverine system, namely the Mackenzie River (i.e., main channel and Delta channels). The same monitoring program is intended to be implemented within the main channel of the Mackenzie River, in the vicinity of Norman Wells, for the Mackenzie River 2D Seismic program, also being proposed by WesternGeco. WesternGeco proposes to complete the monitoring program over a test reach of approximately 100 - 150 km, commencing at a point near the mouth of Reindeer Channel at Shallow Bay, and proceeding upstream into the main channel, and from there, south to the endpoint of the reach. This test reach has been proposed, as it would provide channels of different widths, depths, substrates, and island configurations that would be required to analyse the sound propagation under the diverse situations present within the Delta. The intent of the test program is to develop a "model" of sound propagation and fish effects/behaviour that can be used to predict the impact to fish under various environmental conditions (e.g., channel width, depth, substrate composition, flow rates, etc.). Should the monitoring program prove the assertions presented in the EIA, WesternGeco would request approval to continue with the remainder of the program immediately following testing. Further, if study components show conclusive evidence of success (e.g., fish avoidance) in the first study area (i.e., Norman Wells), WesternGeco would seek approval to amend or delete those same components in the Delta.

Each of the study components are discussed separately in the following subsections.

2.0 Acoustic Monitoring

2.1 Objective

The objectives of this program are to define the following:

- The source level;
- Test and record ambient noise; and,
- Record sound attenuation over distance.

2.2 Scope of work

2.2.1 The source level\Maximum necessary source level

Differing array volumes will be tested with a view to reducing the maximum proposed production volume, within the constraints of good signal to noise ratios and data quality.

2.2.2 Test and record ambient noise in the Mackenzie Delta River.

Record the ambient and background noise in the Mackenzie Delta River.

2.2.3 Produce Sound Attenuation Data

Produce sound attenuation data over distance and depth in the Mackenzie Delta River and Rivers regions with varying geological near surfaces.

2.3 Method

2.3.1 Maximum necessary source level.

The maximum tested array volume for test purposes will not exceed, 1500 cu ins @ 2000psi. Data will be processed onboard using the WesternGeco Omega ® data quality processing system and test results will be analyzed by WesternGeco personnel. WesternGeco proposes to collect data for 10 km using a 1500 in³ source, then 10 km using a 1250 in³, and, then 10 km using a 1000 in³ source. After this sequence has been completed, WesternGeco will utilize the smallest source gun that will provide the quality of data required. This may require returning to the 1500 in³ source if required to consolidate the data, depending on the energy propagation of the substrate under the river.

A nearfield phone will then be placed at a distance of 5 metres below the centre of the array, to test and verify the maximum out-put pressure in bar-m. Far field measurements will be taken at a distance of 250 metres from the centre of the source.

2.3.2 Test and record ambient noise in the Mackenzie River.

Record the ambient and background noise in the Mackenzie River at 4 locations, with and without "river traffic" noting type and size of noise generator.

2.3.3 Attenuation over distance.

During the survey, a hydrophone will be deployed at recorded distances from the source generator, and a set of measurements will be made consisting of a pressure history, water depths and distances from the centre of the array. These dimensions will be measured in: water depths in metres, from 1 metre below the surface down as far as 1 metre above the sub-surface, and a practical minimum linear distance from 50, 100, 200, 500 and 1000 metres, and up to 5 km in 1 km increments. If it is logically practical, this will also be done in the perpendicular azimuth. This test will be completed at least 4 times throughout the duration of the Project. Measured positions will be plotted on a map to show distance and bearings from the centre of the source in a time domain, and entered onto a graph in a pressure and distance domain. Plots and graphs will be cross referenced.

3.0 Fish Effects Assessment

The following fish effects assessment techniques were developed by IMGG senior fisheries staff (John Kelso and Serge Metikosh). These personnel would also be involved in the study implementation, data assessment and report preparation.

3.1 Estimation of avoidance of fish to insonification during ramping of the air gun array.

Fish are expected to avoid water insonified by the air gun seismic array as the program proceeds up the river. The fish will be able to hear the approach of the vessels and the air guns for given period of time before the vessels actually reach the fishes location. This is expected to allow time for the fish to avoid the oncoming noise sources. The ramping-up procedure is expected to allow time for the fish to avoid the noise source over the several minutes that it takes to complete the ramp-up.

To document fish avoidance, WesternGeco proposes to utilize a stationary, side scanning split-beam transducer (e.g., Biosonics, 8 degree cone, 200 kHz) that will count and size the number of fish passing through the acoustic beam during the ramping procedure. A hydrophone will be mounted at that location. As the ramping of the air gun array occurs over time, WesternGeco will partition the counts of fish passage such that they can relate the rate of fish passage, per unit time, with dB. Although the acoustic system will be able to count and size fishes, it will be unable to determine species.

3.2 Estimation of distribution resumption by fishes.

If fish avoid the discharge of the seismic survey air guns, WesternGeco assumes that the return to normal distribution will occur soon after the survey vessel has passed. McCauley et al. (2000) has documented a return to normal behavior patterns within 14-30 minutes after air gun operations ceased.

To determine the effect of the survey process on distribution of fishes, WesternGeco will establish a series of transects at right angles to the survey vessel course and determine abundance, size and distribution of fishes in the Mackenzie River and Reindeer Channel before survey vessel passage (i.e., 8 hrs, 2 hrs, 1 hr), at the time of passage, 0.5 hrs after passage, 1hr after passage, 4 hours after passage and 8 hrs after passage. WesternGeco will conduct this assessment at a minimum of four sites along the survey vessel course. It is proposed that two sites would be

within Reindeer Channel, and two sites would be in the main channel of the Mackenzie River; all sites would be within the 150 km study reach.

By relating mortality and movement (passage through the beam insonified by the 200kHz echosounder) to dB, we expect to be able to infer fish response from assumptions (or measurement) of pressure (i.e., we will have a model by which we can estimate fish response).

The Biosonics acoustic system routinely is used to count smolts in rivers (Thorne and Johnson 1993) today by fish management agencies and has been used to determine reaction of fishes to thermal plumes (Kelso and Minns 1975; Minns et al. 1978), pulp mill effluents (Kelso 1977) and to estimate fish biomass in marine (DFO as an example) and freshwater environments (USFWS and OMNR as examples).

3.3 Contingency Plan

In the event that the Biosonics system is unsuccessful due to the siltation or turbulence of the river, the contingency plan would be to test the direct effects of the airguns on fish.

Fishes may suffer direct mortality from air gun pulses if they are within approximately 2 m of the air gun at the time of the release (Falk and Lawrence 1973; RL&L 1986; RL&L 1998). The proposed approach to determining the immediate effect from insonification by the 1500 cubic inch seismic array would be to cage a fish species (i.e., a species with an air bladder) at varying distances (and insonification levels) from the seismic array. The in-water pressure and noise level (dB) will be measured at 3 reference points (i.e., 5 m, 10 m and 50 m) and inferred (from a plot of dB with distance from the seismic array) at locations between the measurement sites. Soft mesh cages will be placed in duplicate at the 3 reference points and at 2 study locations (2 cages x 3 reference points x 2 study locations = 12 samples), with 5-10 fish per cage. It is suggested that whitefish would be a species that is easily caught by local fishermen, and would provide the appropriate reference for the numerous species that utilize the Mackenzie River.

The first of the proposed reference points would be located approximately mid-point of Reindeer Channel between Shallow Bay and the confluence with the main channel. The second reference point would be located within the main channel of the Mackenzie River, approximately 30 km south of the confluence of Reindeer Channel.

This test will provide a relation of fish mortality with exposure to sound (measured as dB) for the duration of exposure (e.g., ramp-up plus full strength pulses every 8 seconds for 1 minute). After exposure, fish from each reference point at each site will be pooled (6-10 specimens per reference point) and held for an additional 48 hrs to assess "residual" mortality.

This experiment provides a worst case assessment of effect because fishes are unable to invoke avoidance responses, are unable to seek refugia and are exposed for the duration of operation. This experiment would provide a worst case relation of short-term (and "residual") mortality of a sensitive fish species over the range of insonification encountered by fishes as a result of the WesternGeco program.

4.0 Aquatic Mammal Effects

In conjunction with the above fisheries studies, observations by biologists, monitors, or Project personnel, of any aquatic and/or semi-aquatic mammals (e.g., beaver, muskrat, otter, beaver) that occur within the study area, and the reactions to the program, would be noted. Direct observation

during the program was determined to be the most practical way to determine impacts to these species. A standard observation form would be completed by the monitors.

5.0 Injury/Mortality Monitoring

Western Geco will employ monitors from local communities or HTC's that would be responsible for identification and resolution of potential conflicts in front of the vessels (i.e., tourists, flocks of waterfowl, beaver), as well as identification of mortalities by direct observation by the monitors, related to fry, fish, birds and aquatic mammals behind the vessels. Where practical, the scout boats ahead of the vessels would haze wildlife from the immediate area to minimize the potential for conflicts. It is expected that the monitors would follow behind the vessels at a distance that would not interfere with the acquisition of data, but close enough (e.g., approximately 500 m behind the streamer cables) to observe injured fish or wildlife, or mortalities. All fish and wildlife that are collected during the monitoring will be subjected to an in-field necropsy by a qualified biologist to determine the cause of death. The local monitors would be in place for the test programs, but also for the remainder of the program.

6.0 Mitigation

The mitigation options proposed for the program include the following:

- Use of non-explosive techniques for in-water exploration;
- Routing the program in the deepest portion of the channel;
- Scheduling to avoid sensitive spring and fall spawning periods in the appropriate areas;
- Identifying sensitive fish habitat and/or fishing areas to avoid conflict;
- Utilizing ramp-up procedures to scare fish from the Project area prior to commencing shooting;
- Cessation of activities during streamer cable length adjustment; and,
- The above testing and monitoring programs.

In addition, the following mitigation options will be enacted for the Project:

- Evaluation of utilizing a smaller air gun array, depending on data quality;
- Suspension of activities if aquatic mammals are observed within 200 m of the air guns;
- Suspension of activities for 1 hr and subsequent ramp-up if Project induced fish mortality is proven; and,
- Suspension of activities (length of time to be determined in consultation with regulators) in the event that the monitors encounter persistent/constant fish mortality, or more than 10 Project induced fish mortalities are detected within a 1 hr period.

Following the completion of the monitoring programs, a summary report will be provided to the NEB, DFO and RWED that provides: rationale for the study, location, methods, results and discussion sections.

7.0 References

Kelso J.R.M. and C.K. Minns. 1975. Summer distribution of a nearshore fish community near a thermal effluent as determined by acoustic census. J. Fish. Res. Board Can. 32: 1409-1418.

Kelso J.R.M. 1977. Density, distribution and movement of Nipigon Bay fishes in relation to a pulp and paper mill effluent. J. Fish. Res. Board Can. 34:879-885.

Minns C.K., J.R.M. Kelso and W.H. Hyatt. 1978. Summer distribution of nearshore fish in the vicinity of two thermal generating stations, Nanticoke and Douglas Point, on the Great Lakes. J. Fish. Res. Board Can. 35:885-892.

Thorne, R.E. and G.E. Johnson. 1993. A review of hydroacoustic studies for estimation of salmonid downriver migration past hydroelectric facilities on the Columbia and Snake rivers in the 1980s. Reviews in Fisheries Science 1:27-56.