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**EXECUTIVE SUMMARY**

**Technical Review**

of the

**Environmental Assessment for the WesternGeco  
Mackenzie and Liard Rivers  
2D Seismic Program 2003**

for the

Mackenzie Valley Environmental Impact Review Board  
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## Executive Summary

This report evaluates the Environmental Assessment submitted by WesternGeco for their seismic studies of the Mackenzie and Liard rivers. This report is limited to an evaluation of whether the air gun emissions would directly affect the behavior, anatomy, or physiology of fish and does not include other parts of the environmental assessment.

Based upon their studies, WesternGeco concluded that:

- a. There was no impact on free-field fish movement as observed by sonar.
- b. There were no behavioral changes in the fish in cages.
- c. There were no deaths of experimental animals that could be attributed to the exposure to air guns.
- d. There were no consistent changes in pathology of the fishes studied that could be correlated with exposure to air guns, and any pathology encountered was within the normal range of fish health.

If one accepts the experiments performed by WesternGeco as being adequate to test the effects of air guns on fishes, then the conclusions reached are reasonable. However, it is my opinion that the studies done by WesternGeco were *insufficient and inadequate to achieve their goals*, and that no conclusions can be reached about the effects of air gun exposure on fish based upon these studies.

I reached this conclusion based upon a number of issues listed below.

- (1) The animals tested in the cage studies are not representative of the diversity of fish species in the Mackenzie. While it would not have been possible to test all Mackenzie species, the tests would have been much more useful had species more representative of the species diversity of the Mackenzie been used in the cage tests.
- (2) The sound levels to which fish were exposed was not the maximum output of the air guns. The cages used in the study were not placed at the spot of maximum sound level from the air guns (25 m from the source).
- (3) The fish were not observed during the cage tests. Thus, any behavioral changes shown by the fish during air gun stimulation are not known. Having such data are critical since

if fish are affected enough to show aberrant behavior during air gun stimulation they could also be more subject to predation by other (less affected) species during air gun stimulation.

- (4) Fish were sampled for histopathology about 48 hours after the termination of the exposure to sound. This is likely to be an inadequate time interval for ear pathology to show up.
- (5) The number of fish sampled from each test site was inadequate to provide a statistically useful sample for any demonstration of effects, or lack of effects, by the air guns on various tissues.
- (6) Most of the fish sampled for histopathology were from two species which are not representative of most of the Mackenzie species. Therefore, even if there was no damage to these species, it is not possible to extrapolate from these to other species.
- (7) The methods used to prepare the tissues for histopathology were inadequate for proper tissue analysis. Numerous artifacts of the preparation occurred which could hide any pathology.
- (8) Insufficient information is provided about the histopathological results to support the contention of WesternGeco that there were no effects of air gun stimulation. Furthermore, there is no photographic documentation to support the conclusions reached by WesternGeco.
- (9) The intensity and duration of the exposure did not provide a "worst case" scenario for exposure to air guns.
- (10) Behavioral tests to determine if the air guns on moving vessels would herd fish could not observe fish at the surface or near the bottom, thereby potentially preventing examination of animals that live in these regions, or move their in response to the air guns.
- (11) There was no way to know which species were observed in the sonar used in the behavioral tests, and it is possible that only one or two, not necessarily representative species, were observed.
- (12) The arguments used by WesternGeco to suggest that the air guns will not affect eggs and larvae of fish or invertebrates are inadequate and not convincing. WesternGeco did no experiments to demonstrate that their air guns would have no effect on fish eggs and

larvae or on invertebrates, and the literature cited to support the arguments raised by WesternGeco are inadequate.

In order to properly evaluate the effects of the air guns on fish in the Mackenzie and Liard (or anywhere else), particularly to develop a worst-case scenario, caged tests are clearly the most powerful experimental approach. However, they need to be properly designed and executed so that a full array of information is obtained with respect to effects on behavior and pathology in both short and long terms.

Despite my very considerable reservations about the value of the studies performed by WesternGeco, other (albeit limited) data in the literature leads me to the conclusion that the *specific approach* being taken by WesternGeco in their survey work in the Mackenzie and Liard rivers may not have a substantial negative effect on fishes. Because the seismic vessels used by WesternGeco will only be making a single pass at any one point, the likely exposure to maximum signals from air guns for individual fishes (or, for that matter, invertebrates, fish eggs, larvae, etc.) will be no more than for a few minutes, and this exposure will be intermittent since the air guns are not fired continuously, and in most cases the exposed organisms would not be subject to the maximum output of the air guns. The data in the literature on the effects of intense sounds on fish suggests that somewhat longer-term exposure is needed in order to affect the ear, and thus hearing. While these data are very limited, and extrapolation between the few species tested to other species (including to those in the Mackenzie) is not something that can easily be done at this stage in our knowledge, they do suggest that somewhat longer exposure is needed to get damage. Longer exposure might be encountered if the air guns were towed back and forth over a study area, but this is not the case in the WesternGeco project.