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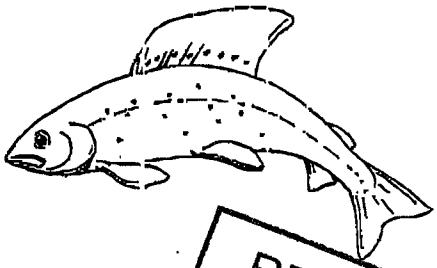

Western Arctic Area
Fish Habitat Management
P.O. Box 1871,
Inuvik, Northwest Territories, X0E 0T0

January 8, 2003

TO/A:	**FAX**
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MESSAGE:

RE: Draft Report "Behaviour and Physical Response of Riverine Fish to Airguns" prepared by IMG-Golder for WesternGeco in support of the Mackenzie River/ Delta 2D Seismic Programs 2002: DFO Comments

Good morning Keith,

I've consolidated Eric Gyselman's comments into the attached letter.

Pete

FROM/DE:

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Your file *Votre référence*

Our file *Notre référence*
SC02052

January 7, 2003

Keith Rosindell
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Suite 2300, 645-7th Ave SW
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T2P 4G8

RE: Draft Report "Behaviour and Physical Response of Riverine Fish to Airguns" prepared by IMG-Golder for WesternGeco in support of the Mackenzie River/ Delta 2D Seismic Programs 2002: DFO Comments

Dear Keith,

As we've discussed, below is a written summary supporting the views of DFO presented by Eric Gyselman, Regional Hydro-Acoustics Specialist, during the workshop in Calgary on December 5, 2002, that he participated in via telephone link. These comments are being provided to assist in the further development and refinement of the Draft Report "Behaviour and Physical Response of Riverine Fish to Airguns" prepared by IMG-Golder for WesternGeco. Many of the comments/ concerns can be addressed through revising the draft report, providing more supporting documentation or outlining project and study design limitations clearly. As I indicated at the December 5 meeting, if there are outstanding issues that cannot be addressed through report revisions, there may be opportunity for them to be addressed in the field during the seismic program if it proceeds.

From DFO's perspective the contents of the finished report will be one of the main considerations when assessing the WesternGeco Mackenzie River/ Delta 2D Seismic Programs 2003.

Start of comments by Eric Gyselman

I think all parties agree that little high quality information is available on the effects of seismic airguns on fish and other aquatic biota in riverine environments. Some information is available for marine waters but this cannot be directly applied to rivers because of the drastically different physical structure in rivers. From a biological perspective, I have two critical concerns: 1) does the sound spectrum and intensities of the seismic airguns adversely affect biota in river and 2) can the biota successfully avoid the potentially harmful sound source. We discussed these issues in the spring and subsequently made recommendations to

WesternGeco and IMG-Golder that we felt would begin to attempt to answer these questions.

IMG-Golder's biological program had three components:

1) an experiment to measure the potential lethal and sublethal effects of the seismic sound source on fish,
2) an experiment to measure the swimming reaction of fish to the seismic sound source
3) an experiment to measure fish avoidance of the seismic sound source, specifically 'herding' upstream in front of the seismic ship

In my view, the experimental design of the three experiments was reasonable especially considering the operational constraints that IMG-Golder was expected to carry out this research with. Time was limited and experimental fish of the size and species required were difficult to catch. Given these constraints, I believe IMG-Golder did a reasonable job in achieving their objectives. However, their results are by no means conclusive and I do not believe that the definitive conclusions presented in the draft report can be substantiated by the data presented. The following are my principal concerns:

1) Potential Lethal and Sub-lethal Effects

The species and range of sizes in each species used in Experiment #1 was limited. In fact, no coregonids, the species that make up almost the entire subsistence fishery in the lower Mackenzie River and Delta, were used. The species that were used are considered 'hardy' relative to the whitefishes. Therefore, the potential impact of the seismic airguns on the subsistence fishery is still unclear. Of particular concern is the impact on the large number of young-of-the-year that are carried out of their natal streams and into the Mackenzie River in the spring. In my opinion, this is a critical issue. We do not fully understand how this migration takes place and these small fish do not have the swimming capability to avoid the seismic survey ship. I am also concerned that some of the fish in the cage closest to the airguns were apparently 'stunned' but that no one from IMG-Golder could explain the physiological effect that resulted in the 'stunning'. The fact that the necropsies showed no gross physiological abnormalities seems to result in the conclusion that the fish were unharmed. I would argue that 'stunning' is a consequence of exposure to the sound. The physiological cause is still unknown and since the observation time after exposure was short (48-hours), the long-term effects of the sound are not known. I do not believe from this work that we can conclude that the seismic airguns will have no effect on biota in the Mackenzie River and, of particular concern, that the seismic survey will not impact the subsistence fishery in the three land claim areas.

2) Swimming Reaction

The experiment to measure the reaction of fish to the seismic airgun by aiming the beam of the scientific sounder horizontally along the airgun array was a valid design to achieve the objective. However, the results presented are minimal. In the draft report, no explanation of the methodology used to actually calculate the

swimming vectors was presented nor were any data presented other than one table that stated that only one fish moved away from the array. Furthermore, the sample size of tracked fish was small (<40), all of the targets were small, and the experiment was only carried out at one location. IMG-Golder also seems to assume that the only possible swimming vector that would demonstrate a reaction to the airgun is a horizontal one away from the airgun. Other vectors are possible and, in fact, the fish may react in a chaotic manner if they are stunned or partially stunned as was demonstrated in the cage experiment. Perhaps a change in vector or velocity would be a better measure of effect than simply looking for a preconceived behaviour. I was also concerned with lack of a clear understanding of the difficulties of acoustically tracking fish movement. Obviously, my concern is based on the limited discussion with the IMG-Golder staff during the workshop and the material presented in the draft report. However, I have spent a considerable amount of time working with colleagues in Alaska and with DFO Pacific on fish tracking in rivers and I am not convinced (although my mind could be changed) that these results are valid. For example, when I asked IMG-Golder whether they had used target strength as a parameter for determining a fish track, they responded that they had. In fact, target strength is a very poor parameter to use because it is so highly variable depending on the aspect of the fish that is presented to the beam. Apparently, no validated software was used to track targets. It seems to have been done by simply looking at target locations in subsequent pings and assuming they were the same fish. Finally, no information was collected on the species of fish being insonified. Therefore, the use of the generalized term 'fish' in the report and particularly the conclusions is not supported. The fish could have all been of one species, for example. Certainly the fish insonified are not representative of the all of the fish in the Mackenzie River because the targets were all quite small acoustically which, by inference, are small physically.

Read w. Hard

3) Fish Avoidance

In an attempt to measure avoidance behaviour of fish with the passing of the seismic ship, IMG-Golder ran a series of transects across the river well before, immediately before, immediately after, and well after the seismic ship passed a particular location. Four transects were run in each of the three test areas in an effort to look at a number of different bottom contour shapes. The hypothesis was that the fish would be 'herded' upstream as the vessel approached. Consequently, this was the only avoidance behaviour considered to be significant. In my opinion, the survey design was reasonable but the way the experiment was conducted was flawed. My primary concern is that a number of assumptions are made that were not validated resulting in results that must be considered suspect I can think of three that may have a significant impact on the interpretation of the results. First, each series of transects was carried out over a 6 to 8-hour period IMG-Golder assumes that the distribution and density of fish did not change naturally over this time period. Second, IMG-Golder assumes that each transect is run over exactly the same track and therefore they are measuring exactly the same cross-section of river on each transect. In a dynamic river such as the Mackenzie this is nearly impossible. Finally, IMG-Golder assumes that the acoustic survey launch has no

impact on the density and distribution of fish in the river, that is, the fish demonstrate no vessel-avoidance behaviour towards their launch. The degree to which these assumptions affect the results is not addressed in the draft report. However, in my opinion, a violation of any of these assumptions could result in a bias in the measurement of the distribution and density of fish that could mask the true behaviour of the fish to the seismic survey ship. I believe a number of other problems exist with the data collected. Almost all of the targets are very small. IMG-Golder predicted that the mean length of the targets calculated from Love's conversion of target strength to body length was about 15-cm. From modelling work we have done in my lab, I believe the mean is closer to 10-cm. However, the point is that almost all of the targets are small. Very few large fish were seen acoustically. I can think of three possible reasons for this: 1) they were not in the river, 2) they were not in the part of the river being surveyed, or 3) they exhibited avoidance behaviour towards the acoustic survey launch. Reason #1 seems unlikely given the high density of migratory species in the river. Reason #2 is possible considering that in some cases half the river was too shallow to survey acoustically. In other large rivers (ex. Fraser), migrating fish stay very close to the bottom and near the shore because that is where the current is lowest and consequently they expend the least amount of energy to swim. If this is the case in the Mackenzie, then many fish would be missed. Vessel avoidance (Reason #3) has been well documented for many species including coregonids. The narrow beam used in this study (7 dg) has a very small footprint (1.2-m in 10-m of water depth). Fish in the water column below the survey vessel need only move a very short distance to the side to be out of the beam. The result of this under-representation of large fish is that no conclusion about their behaviour relative to the seismic survey ship can be made irrespective of violations of the other assumptions discussed above. A final concern that I have with this part of the study was that no attempt was made to identify which species were being insonified. Consequently, we do not know whether the results apply to all fish species in the Mackenzie or whether only one or two species that were actually measured acoustically. All of my comments in this section lead me to question the certainty of the conclusions reached in the draft report. We do not know whether the measured changes in density and distribution were caused by the influence of the seismic survey ship, we do not know whether the density and distribution fish observed acoustically was representative of all sizes of fish in the river, and, finally, we do not know whether the density and distribution observed was representative of all fish species in the river.

All of the criticisms above must be taken within the context of the conclusions presented in the report. Useful information was collected during this study. However, it was not definitive. The conclusions imply that we now have a very clear understanding of the behaviour of fish (apparently all sizes and species!) in the river with respect to the seismic survey and that the seismic survey will have no impact on the fish. Regardless of whether this proves to be ultimately true or not, the evidence from this study does not clearly support this conclusion.

I also have a few minor points that I would like to see cleaned up in the final report for the sake of clarity and to prevent misunderstanding and confusion.

1. In the text of the report, the authors call the scientific sounder both a split-beam system (which it is) and a dual-beam system (which it is not) (ex. Page 7). These are two quite different acoustic systems. Three-dimensional target location cannot be done with a dual-beam system.
2. On page 10 and other locations, the authors give a ping rate of 1 ping every 4 seconds. I believe they mean 4 pings per second.
3. The authors give not indication of the duration of each of the transect series which apparently was about 6 to 8 hours. I only found out by asking during the workshop. A table of transect start and stop times should appear in the text or appendix.
4. The beam width and pulse length are not given in the text. This is important information. I only discovered what they were by looking at the header file for the sample data output in the Appendices.
5. No methodology, analytical procedure, nor vector map is given for the target tracking experiment. A rudimentary table is supplied but this is insufficient.

End of comments by Eric Gyselman

If you have any questions feel free to contact me at (867) 777-7520 or Bruce Hanna at (867) 669-4931.

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