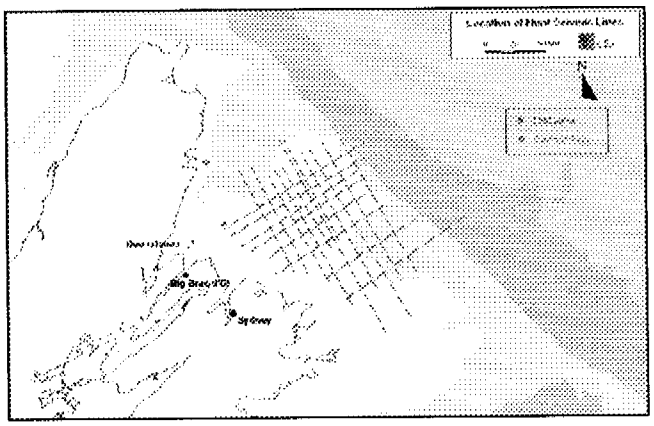
Environmental Effects Monitoring Program for Hunt Oil Company of Canada's Seismic Survey in Sydney Bight



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October, 2005

Final Hunt EEM Program

Revised October 25, 2005

INTRODUCTION

This report presents the design and methodology for conducting an EEM program for the proposed Hunt Oil seismic survey in Sydney Bight. The EEMP is to be conducted at the onset of the seismic survey, which is scheduled to begin November 1, 2005.

This document reflects input from Fisheries & Oceans Canada and the CNSOPB on an earlier draft program dated September 19, 2005. This report provides the framework for completion of the monitoring program and more detail on specific aspects of the methodology to address comments by Fisheries & Oceans Canada.

TEST HYPOTHESIS

The EEM program is designed to determine the threshold at which sublethal damage to ear structures of fish, in this case Atlantic cod, occurs. The EEMP provides a direct connection to the predictions of the EA in relation to potential effects on young fish in the Bird Islands area, an area known as a juvenile nursery area for cod. The EA predicted that the Bird Islands were beyond the range of sublethal effects. The test location has thus been selected to be near the survey line closest to the Bird Islands.

The test hypothesis is that no damage to ear structures occurs at distances greater than 500 m from a peak to peak sound pressure level of approximately 259 dB re 1 μPa at 1 m. Figure 1 provides the far field signature of the Gulf Pacific array proposed for use in Hunt's survey.

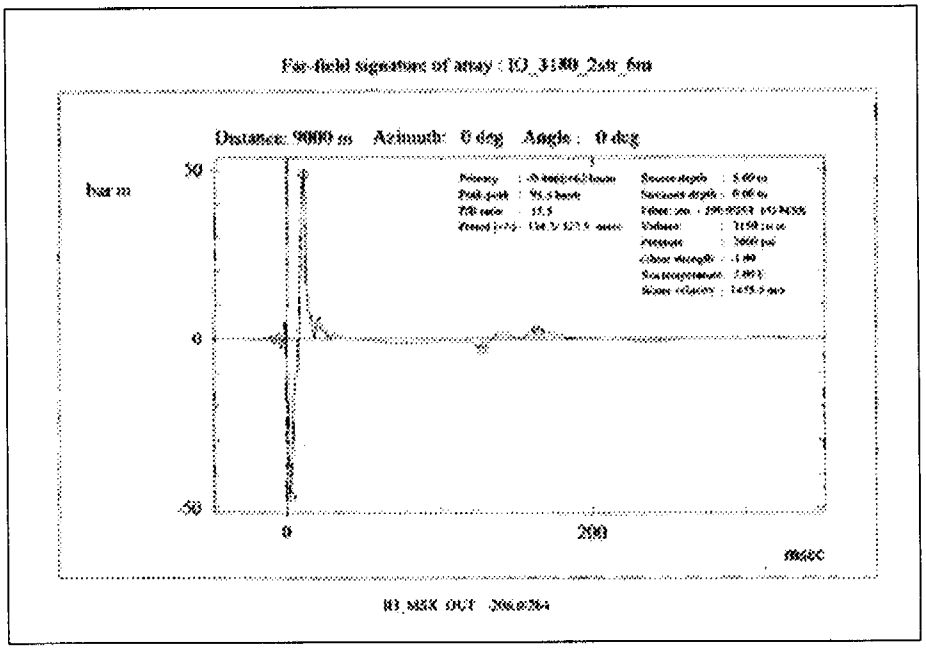

Figure 1: Far Field Signature of the Gulf Pacific Array

Figure 1 indicates a peak to peak maximum pressure of 95.5 bar m, which is about 259 dB ref 1 μPa at 1 m (peak to peak) or 248 dB RMS. The environmental assessment considered the impact of airgun arrays with peak to peak pressures ranging from 240 to 260 dB ref 1 μPa at 1 m.

Figure 2 illustrates the theoretical attenuation with spherical or cylindrical spreading. Both types of spreading are used in the graph to provide bounds to the anticipated pressure levels at the test sites. Spherical spreading is most likely initially, but either type may occur in a horizontal direction away from the sound source. The graph provides a range of possible sound pressure levels at the bottom, excluding effects of attenuation from other sources, such as bottom roughness. Thus, actual pressure levels are anticipated to be lower than those shown in the graph with distance.

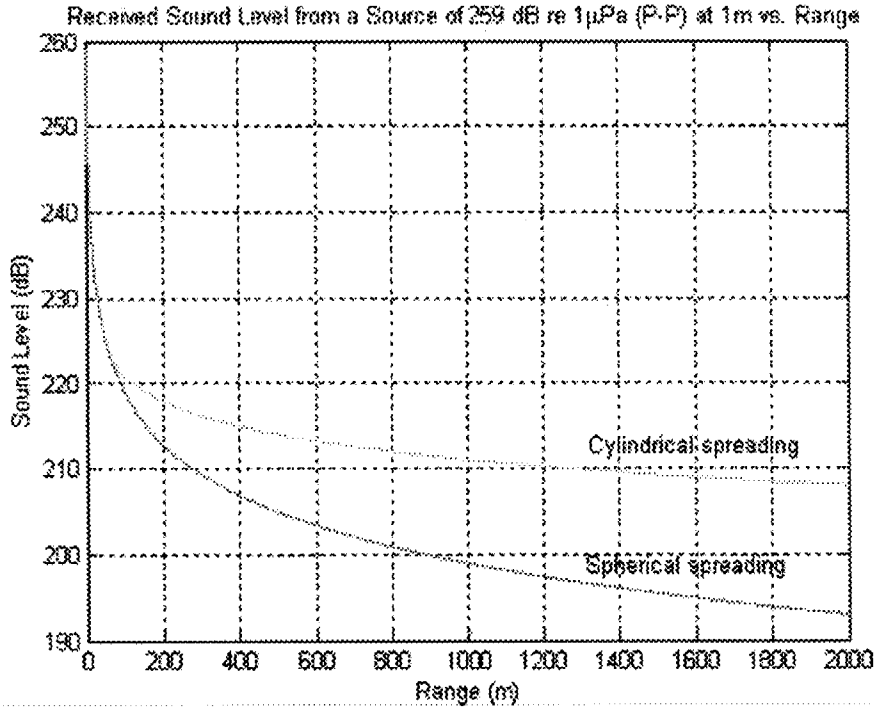

Figure 2: Theoretical Attenuation with Spherical and Cylindrical Spreading

Modeling of long-range attenuation usually uses a number of runs at different frequencies (1/3 octave bands) with the results combined to obtain the numbers for the entire frequency spectrum. At closer ranges, e.g., less than one kilometre from the airguns, attenuation may be better predicted using the theoretical equations. Figure 2 suggests the sound pressure will decrease rapidly with distance from the airguns, lowering to about 220 dB, ref 1 uPa at 1 m, at a distance of 100 m from the airgun array.

Specific estimates of sound pressure thresholds where fish ear injury begins to occur are not available from previous studies (McCauley et al. 2003); however, fish are known to begin experiencing non-auditory internal injuries at sound pressure levels of around 220 dB ref 1 µPa at 1 m (Turnpenny and Nedwell 1994). Figure 2 suggests that this sound pressure level may exist at about 100 m from the path of the seismic vessel. To cover the likely range of distances where a threshold level may occur, cages will be set a 100 m, 500 m and 1000 m from the seismic survey vessel path.

TEST ORGANISM

Hatchery reared fish will be used in the EEM program to ensure all fish are consistent in genetic and physical quality. Young Atlantic cod, approximately 10 to 15 cm in length, will be obtained from the GreatBay Aquaculture facility in Portsmouth, New Hampshire. Fish will be shipped to the Halifax International Airport by air freight and trucked to the Big Bras d'Or wharf in Cape Breton for temporary storage in cages until the EEMP is

ready to begin. The application to transport these fish is provided as Appendix A to this report.

All fish will be similar in size and age. Use of a single size/age class of fish reduces the number of variables and increases the statistical confidence in results. The study is not intended to examine the potential effect of fish size or the impacts of sound on mature fish.

Five fish will be sacrificed at the onset of the study to provide a reference comparison for test and control fish. Three reference fish will be used to provide a reference for ear studies, and two will be used for reference for other tissues. All fish are expected to be in their second year and about 10 to 15 cm in length.

One hundred fish will be obtained, allowing for up to a 25 percent mortality of fish prior to the testing. All reference, control and test fish will be exposed to the same conditions. Reference fish will not be sacrificed until the test program is ready to commence. Test and control fish will be subjected to the same holding and transportation treatments, and all efforts will be made to find similar bottom substrates and temperatures for cage deployment.

TEST AND CONTROL SITES

The proposed test and control sites are illustrated in Figure 3. The test location is along the survey line that is the closest to the Bird Islands. The control site, near Ingonish, is approximately 50 km away from the test site. Both sites are in approximately 70 to 80 m of water. Test site vessels will berth at Big Bras d'Or, while the control site vessel will probably berth at Ingonish Harbour.

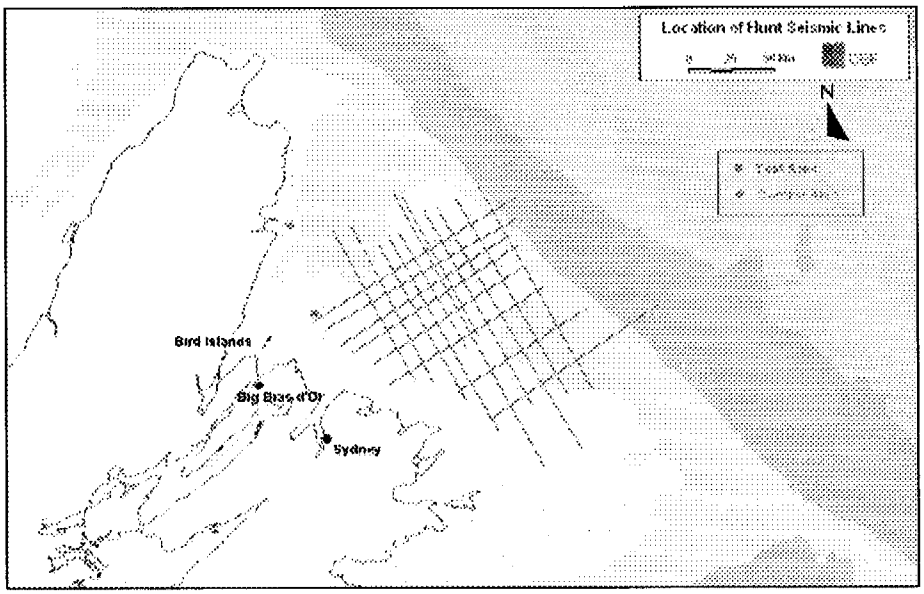

Figure 3: Location of Test and Control Sites for the Hunt EEMP

The test site was selected because of its proximity to the Bird Islands, but it is still at a distance of approximately 25 km from the islands as indicated in Figure 3. The control site was selected because it had water depths similar to the test site, it was relatively close to shore and the test area, and the location was well removed from competing sources of noise, such as routine shipping, ferries or gypsum vessels.

TEST EXPOSURE AND CONTROL TREATMENT

Fish will be deployed in used steel-frame crab cages with interior trap components removed and ½-inch mesh netting added. These cages will be used for storage at the wharf as well as for test and control deployment. For test and control conditions, no more than five fish will be placed in each 1.2 m long cage to minimize any effects of fish crowding on results. Table 1 provides the number fish required for reference, control and each test replicate.

Table 1: Number of Fish by Test Group and Control

	Distance from Survey Line			Control/Reference
Fish Group	100 m	500 m	1000 m	
Reference				5
After 5 hour exposure	10	10	10	10
After 5 day exposure	10	10		10
Total	20	20	10	25

NOTE: Each group of 10 fish represents two fish that will be sent to Dr. Groman at University of PEI for general histological examination, and eight fish (16 ears) that will be sent to Dr. Popper at University of Maryland for review of potential ear damage.

Test and control fish will be treated identically. All fish will be placed in bags for transportation to the test and control sites. Cages will be set the day prior to the pass by the seismic survey vessel. If a soft start is required, a minimum duration is preferred to limit disturbance of fish prior to the passage of the vessel with the airguns operating at full power. Alternatively, data can be acquired on a southwest heading and the soft start can occur at the northeast end of line, well removed from the test area. At the test site, three sets of cages will be set at approximately 100, 500 and 1000 m in a line perpendicular to the path of the seismic survey vessel.

Previous study has indicated that some injury may take time to become apparent. To account for delayed expression of injury, fish will be left at the site for at least five days following the test exposure. During this time, seismic survey activity will be focused on the outer lines close to the Laurentian Channel. Close liaison with the survey manager will be maintained to ensure the fish are removed before lines within 20 km of the cages are run to avoid possible cumulative exposures.

SAMPLE PREPARATION AND ANALYSIS

Two cages of fish will be retrieved approximately five hours after the survey vessel has completed its pass with airguns active. Fish will be sacrificed and ears of eight fish removed and prepared for shipment to the University of Maryland for analysis. Removal and preservation of ears will be carried out by Ray Soper of Oceans Ltd. (Ray was trained by Dr. Popper and did the tissue removal and sample preparation for a previous study on tuna). Electron Microscopy grade fixatives (gluteraldehyde and paraformaldehyde) will be used. The fixed ear tissue from both ears will be sent to Dr. Popper at University of Maryland for analysis of the three otolithic end organs in each ear.

Two remaining fish from the two cages will be sacrificed and preserved for shipment to the Veterinary College in Charlottetown. Dr. David Groman will prepare slides of liver, gonads, and brain and review them for abnormalities compared to the reference fish.

Samples will be prepared immediately on arrival back at the Big Bras d'Or wharf, or if weather is inclement, at a local facility nearby. All samples will be placed in appropriate preservative for shipment to either the University of Maryland or the Veterinary College.

Additional cages of fish will remain in the water for at least five days at the two closer test sites and at the control site. These cages will be recovered after five days and fish treated as described above. The fish from these cages will provide a check for injuries that are delayed in appearance after the original exposure, with a test hypothesis that the fish from cages recovered initially and those recovered days later should show the same injuries. The number of fish analyzed from the second set of cages will be dependent on the results provided by first set of samples, and initial results from a few fish.

IN SITU SOUND MEASUREMENTS

Sound will be measured in situ at the test and control sites. Hydrophones will be attached to the cages approximately 1 m above the bottom. Sounds measurements will be recorded from a cable run to a fishing vessel anchored nearby. Measurements will be made at the test sites 100 m and 1000 m from the survey line, and at the control site. Thus, three hydrophones and data acquisition systems will be required.

REPORTING

Initial results of the EEMP should be available within two weeks of completion of the study. These results will include sound pressure levels measured at test and control sites, a chronology of major events, and an overview of obvious injuries or fish mortality. It is anticipated that results from the analysis of ear tissue conducted by Dr. Popper will not be available for nine to 11 months following the study. Results of all analytical study will be made available to the CNSOPB, however, as soon as possible after receiving reports from the researchers involved. A final report on the EEMP is anticipated by the end of November, 2006.

REFERENCES

McCauley, R.D., L. Fewtrell and A.N. Popper. 2003. High Intensity Anthropogenic Sound Damages Fish Ears. J. Acoustical Sc. Am. 113: 638-642.

Turnpenny, A.W.H. & Nedwell, J.R. 1994. The Effects on Marine Fish, Diving Mammals and Birds of Underwater Sound Generated by Seismic Surveys. Fawley Aquatic Research Laboratories Ltd, Fawley, Southampton SO45 1TW. Available from United Kingdom Offshore Operators Association, 3 Hans Crescent, London, SW1X 0LN.

APPENDIX A - FISH TRANSFER APPLICATION

Fisheries and Oceans Canada / Pêches et Océans Canada

Project No. .....
Indigenous / Non-indigenous
Triploid / Introduction

INTRODUCTIONS AND TRANSFERS
DEPARTMENT OF FISHERIES AND OCEANS
MARITIMES REGION

1. APPLICANT INFORMATION

Name:	CEF Consultants Ltd.
Address (complete postal & street address):	5443 Reeves Drive Halifax, Nova Scotia B3J 1P6
Telephone Number:	902 420-0505
Fax Number:	902 425-4807
E-mail address:	noelina@cefconsultants.ns.ca
If a business, name of contact person and position:	Norval Collins, MCIP, President
If an aquaculturist, Aquaculture license number:	

2. NATURE OF REQUEST

Specify the nature of the request. Describe the culture method being used. If application involves a existing facility, provide a summary information of the existing or proposed facility. Please provide attachments as required.

Fish are to be used in support of an Environmental Effects Monitoring Program for a seismic survey to be conducted in Sydney Bight in November, 2005. The monitoring program is being carried out under the authority of the Cassidy Nova Scotia Offshore Petroleum Board with advice and cooperation from DFO. Fish will be placed in cages on the seafloor and exposed to sound pressure waves from the seismic airgun array. Approximately 50 fish in three cages and one control group will be used. Four fish will be placed north of the Bird Islands and control fish will be outdoors at Ingonish Harbour, both in Sydney Bight.

A total of 100 cod fish, 4 to 6 inches in length, have been ordered from the Cheshire Aquaculture LLC, 183 Gosling Road, Portsmouth, NH 03801 USA. Fish will be shipped to Halifax International Airport from New Hampshire and transported to the Big Tuna DFO vessel by truck for holding in cages. At the onset of the test period, ten fish will be sacrificed as pre-site reference for fish conditions. The holding period should be no more than a few days. Fish in cages will then be exposed to the seismic survey and control locations. Immediately following the passage of the seismic survey vessel, approximately 2/3 of the fish will be sacrificed and dissected for shipment to a laboratory at the University of Maryland at the Veterinary College at UPEI. The remainder of the fish will be sacrificed nine weeks after the exposure and shipped for laboratory analysis.

None of the fish will be released into the environment. Any cod alive at the end of the test period will be destroyed or turned over to DFO at Bedford facilities.

Fisheries and Oceans Canada / Pêches et Océans Canada

Project No. _____

Indigenous: ___ New to Aquaculture: ___
Transfer: ___ Introduction: ___

INTRODUCTIONS AND TRANSFERS
DEPARTMENT OF FISHERIES AND OCEANS
MARITIMES REGION

3. REQUEST FOR LICENSE TO RELEASE OR TRANSFER FISH

Common Name :	Atlantic cod		
Scientific Name & Strain :	*Gadus morhua*		
Life Stage :	Adult		
Gender:	☐ All Female	☐ All Male	☒ Mixed
Number & Size of Fish to be Transferred	100 44 inch		
Proposed Dates of Shipments	October 31, 2008		
Method of Shipment :	Air		
Method of disinfection/disposal of transfer container(s) & related material(s) :	plastic shipping bags and cage netting will be disinfected with bleach if required.		

Has this type of transfer been carried out before? ☐ YES ☒ NO

If YES, indicate when and license number _____
Please indicate date of last transfer above

Will you require this same type of license next year? ☐ YES ☒ NO

4. ORIGIN OF STOCK

Name of person, company, or establishment:	Greatbay Aquaculture LLC
Address (complete postal & street address):	150 Gosling Road Portsmouth, NH 03801 USA
Telephone Number:	603-430-8057
Fax Number:	603-430-8059
If a business, name of contact person and position:	George Nardi, Vice-President
Location of supply (hatchery or water body and lease #):	Pocatiqua farm, north of Boston

Fisheries and Oceans Canada / Pêches et Océans Canada

Project No. .....

___ Indigenous ___ Non-indigenous
___ Transfer ___ Introduction

INTRODUCTIONS AND TRANSFERS
DEPARTMENT OF FISHERIES AND OCEANS
MARITIMES REGION

5. **DESTINATION OF STOCK (Hatchery, Nursery, Grow-Out Site, Other [describe])**

Name of person, company, or establishment:	CEF Consultants Ltd.
Address (complete postal & street address):	34440 Kalonia Drive Halifax, Nova Scotia B3J 1P6
Telephone Number:	902 425-4602
Fax Number:	902 425-4607
E-mail:	mcollins@cefconsultants.ns.ca
If a business, name of contact person and position:	Norval Collins, President
Location of culture facility water body, County and lease #:	Big Bras d'Or, Cape Breton
Description of recipient & surrounding watershed & physical conditions where fish will be released (include a map of the specific area showing river drainage, impoundments, dikes, wharves, bridges, etc.	No fish will be released

6. **DISEASE PROFILE**

Please provide any available information on the disease profile of the stock being released or transferred. A copy of any specific pathogen or disease-free certificate should be attached. Attach appendix as required.

See health history attached.

7. **ADDITIONAL INFORMATION**

Please identify any potential user interaction and conflicts that this release or transfer activity may have with other user groups (First Nations, commercial fishers, recreational users, landowners, etc.), and any mitigating measures that could be implemented. Applicants should supply any other information that they feel could help further describe what it is they intend to do.

This project is being conducted with advise and cooperation from DFO. A First Nations biologist will be involved in conduct of the study. No potential risks or conflicts exist because no fish will be released.

Norval Collins, MCIP — October 12, 2005

Applicant Signature **Date**