# REVIEW OF EXXONMOBIL CANADA'S 2006 OFFSHORE ENVIRONMENTAL EFFECTS MONITORING REPORT

## Context

DFO Maritimes Science was provided with ExxonMobil's 2006 Sable Offshore Energy Project Environmental Effects Monitoring (EEM) Program Report on April 12, 2007 and were provided with ExxonMobil's plans for a 2007 Offshore EEM Program on May 4, 2007. DFO Maritimes Science was then asked by the Oceans and Habitat Management Branch to review these documents in preparation for a meeting with the Canada-Nova Scotia Offshore Petroleum Board and proponent on May 15th. This meeting was subsequently delayed until May 28, 2007. At this time, DFO Science was asked to prepare written comments on the 2006 EEM Report and 2007 EEM proposal for submission to the Canada-Nova Scotia Offshore Petroleum Board by June 8, 2007. Given the short timeline to prepare a response, DFO Maritimes Science determined that a Special Science Response Process would be used. Environmental Effects Monitoring Reports for the Sable Offshore Energy Project have been reviewed by DFO Maritimes Science in previous years.

## Background

The Sable Offshore Energy Project's EEM Program was designed to evaluate predictions made during its Environmental Assessment process. The scale and scope of this environmental effects monitoring program has been reduced over time. In 2006, the proponent monitored benthic habitat and fish density, produced water chemistry and toxicity, marine mammals during pile driving activities at the Thebaud site, seabirds, and air quality. This Science Response includes the DFO Science review of monitoring results for benthic habitat and fish density, produced water chemistry and toxicity, and marine mammals. Environment Canada generally reviews monitoring results for seabirds and air quality.

## Analysis and Responses

No overall synthesis of conclusions based on the results of 2005 and 2006 monitoring is presented in this monitoring report. This makes it difficult to determine whether the results of this EEM program have addressed its stated goals and objectives, i.e., whether mitigation has been effective and environmental assessment predictions have been verified. Given that this is only the second year of monitoring at the Thebaud platform, it is not expected that major conclusions could be drawn for all aspects of the program at this point in time. However, subsequent monitoring reports could better describe and/or display the trends in monitoring results and discuss how these trends compare to predictions and/or end points.

Sediment quality monitoring was not conducted in 2006. Enhanced sediment monitoring, including attempts to determine the fate of dispersed material, had been recommended in DFO's scientific review of the 2005 EEM report. Potential opportunities to conduct continued sediment quality monitoring should be explored in collaboration with DFO.

## Introduction

The boundaries of the Gully MPA and location of zones 1-3 are incorrect in Figure 1-4.

## Benthic Habitat and Fish Density

Benthic habitat and fish density was evaluated using VHS video recordings and images taken during routine inspections and surveys with a remotely operated vehicle.

Given that there was no statistical design associated with this component of the EEM program, it would be difficult to fully evaluate the impact of production activities on benthic habitat and fish density along the pipeline and at the Thebaud platform based upon the EEM results presented in this report. Other than percent coverage of the pipeline by marine growth, only qualitative observations are presented. Additional numeric results, such as numbers of lobsters/sq meter, would have been more useful for analysis. In addition, some form of "BACI"-design (before-after-control-impact statistical design) may have been useful to help evaluate the success of mitigation and the validity of the environmental assessment predictions. Random visual surveys along pipelines and bird-transects may not be an effective sampling design to examine biological effects of industrial activity.

No comparison has been made between the 2006 results and results from previous years. Comparison of monitoring results over time would be facilitated if monitoring was conducted at a series of standard locations with standarized protocols. Rather than focus on “indicator” species, full analysis of all species that can be recognized in the images collected is encouraged. Sediment or habitat type should also be noted where possible.

Sediment cores looking at changes in chemical signatures and perhaps diatom species composition with depth would be very useful.

Overall, the 2006 EEM results were considered to be inconclusive.

## Produced Water Chemistry and Toxicity

In 2006, produced water samples were collected from Thebaud, South Venture and Venture. The full set of Microtox and sea urchin fertilization tests were only carried out for the Thebaud samples.

LC50 analyses of produced water indicates that it has some toxicity, and levels from 1 to 10 % (depending upon the organism) can produce deleterious effects. Field concentrations as a function of distance from source areas were not sampled, so it is difficult to determine the relevance of these results in field conditions. References on predicted dilution rates or results from modelling studies would help to determine if this is an issue; however, given the potential for water re-circulation eddies in the area, field measurements may be required to provide an accurate picture. However, if the acute toxicity of the production water at Thebaud is determined to be essentially negligible, emphasis should be placed on evaluating the potential for chronic toxicity. The potential long-term effects of low exposure are not mentioned in this report. Only short-term exposure is considered. Long-term exposure may cause deleterious effects even at very low concentrations.

Given that Fe and other hydrolysis metals are likely to precipitate out of solution, focus should be on transport and fate of components of concern. PERD studies suggest that produced water contaminants may become concentrated in the surface microlayer and sediments.

Given reports of endocrine disruption in laboratory studies of produced water conducted in Norway, it would be helpful to assess the impacts of different types of phenols that may be present in the produced water. Further analysis could also be conducted to determine if solutions with similar salinities but with no hydrocarbons or phenols present would produce the same types of effects in the Microtox and Sea Urchin Fertilization tests, as there is potential for false positives in the biotests utilized due to the influence of salinity, ammonia, etc.

In response to emerging environmental concerns, improvements in biotest protocols and methods for risk analysis have been developed on the east coast (e.g., Memorial University) and in other parts of the world (e.g., Norway) since the start of SOEI's EEM program in 2006. These developments have not been incorporated into the current EEM program design.

Table 3-1 indicates that the levels of many of the chemicals measured at the Venture site are an order of magnitude or more higher that the other sites, including the South Venture site located nearby. It would be useful to include some explanation of this result in the report.

Generally speaking, SOEI's 2006 EEM program on produced water chemistry and toxicity was quite rudimentary. Based on the information provided, it would not be possible to answer a variety of questions about potential impacts, effectiveness of mitigation, etc.

## Underwater Noise and Marine Mammals

This component of the EEM program could be renamed "Marine Mammals and Sea Turtle Observations" to more accurately reflect the current program design.

The objective of the 2006 marine mammal monitoring was to "carry out observations for marine mammals and sea turtles during pile driving activities" conducted between May 19-21, 2006. This objective does not reflect an intent to use monitoring results to determine the effectiveness of mitigation or to verify the conclusions of the environmental assessment. In addition, the objective does not clearly state that any observations made during pile driving would be compared to observations of marine mammals conducted in the days before and after pile driving activity. Given that additional observations were conducted, these should be presented as an integral component of the EEM results. For example, all marine mammal observations could be displayed along a timeline that clearly indicates when pile driving was occurring. These results could then be analyzed to formulate a tentative conclusion as to whether pile driving may or may not have had an impact on marine mammal behaviour around the Thebaud platform.

No monitoring of underwater noise levels was conducted in 2006. However, noise levels during piledriving at the earlier Venture site were monitored in 1998 and are reported in the current 2006 EEM report. Noise levels measured at Venture in 1998 were used to determine the 500 m safety radius for marine mammal monitoring at Thebaud. Given that noise propagation is dependent on site characteristics, such as depth, a comparison of the Venture and Thebaud site characteristics would have been useful to determine if assumptions made were appropriate.

The broadband noise levels cited for the 1998 Venture piledriving operations (170-175 dB @ 1.5 and 1.9 km respectively) are roughly 10 - 15 dB lower than might be expected from an airgun seismic survey at similar ranges in Continental Shelf depth waters. The Venture acoustic

measurements were used to establish the 500 m safety zone for the May 2006 piledriving operations at Thebaud. Reported Venture levels of 170 - 175 dB (RMS ?) at 1.5 and 1.9 km in a shallow water environment would translate to acoustic levels about 5 - 6 dB higher at the outer edge of a 500 m safety zone assuming 10 log R cylindrical spreading in a shallow water environment with negligible bottom and water absorption. Therefore, the 500 m safety zone should be viewed as defining the radius of potentially damaging sound levels (~180 dB) rather than defining the radius of temporary behavioural changes (~170 dB), which would likely extend out to at least several kilometers. Behavioural effects, at least for baleen whales, may occur at acoustic levels down to 160 dB or lower. It should be noted that the low frequency cut-off for the earlier noise measurements at Venture was 45 Hz. This corresponds to the approximate waveguide cut-off frequency for shallow water (25 m depth) acoustic propagation over a soft-sediment bottom. Lower frequencies can be safely ignored.

In the future, protocols for how to respond to sightings of dead fish (i.e., potential options for retrieval of dead fish), should they occur, may be useful to provide to observers prior to piledriving operations.

## Fish Health

Monitoring of fish health and mussel body burden was conducted in 2005 but not in 2006.

The biological component of the EEM program on the Grand Banks includes (a) sediment bioassays (b) benthic community structure and (c) fish health, as assessed by early warning health effect indicators (namely MFO) and histopathology. This is in addition to fish morphometrics (e.g., age, fish and organ condition). This approach, which is supported by water and sediment chemistry, is in line with recommendations made by the Oslo-Paris Commission over a decade ago as a “core” for biological monitoring programs in general – with the understanding that new components might come on line in accordance with new research and validation. This is also the approach found in many formal and informal programs since then (with selected “add-ons” depending on purpose). Fish contamination and tainting which is of major socio-economic importance is also a core component of EEM on the Grand Banks.

Health effect indicators are recognized to be an important component of fish health studies since fish morphometrics alone, such as change in fish and organ weights, can be insensitive indicators of fish health problems due to their timescale for occurrence. They can also be highly variable in relation to feeding providing considerable potential for type 1 or type 2 errors. Furthermore, animals injured at a site in the short term may suffer unrecognizable mortality, move away from the site and suffer unrecognizable mortality or be rapidly removed by predation with the niche being rapidly filled by fish in good condition. Thus, fish in “good condition” might be commonly obtained at any specific sampling site near an effluent, resulting in a situation with considerable potential for type 2 error.

Overall, the use of fish morphometrics alone (as recognized by various agencies) can present major problems in EEM programs, even in small bodies of water – brooks, rivers, lakes. Understandably this problem would be greatly magnified on the open sea where major/catastrophic impacts would likely have to occur before they could reasonably be linked to a contaminant cause. It is important to note in this regard that cod condition varies naturally over quite small geographic areas in the offshore.

The use of health effect indicators can be a critical supplement to use of fish morphometrics, especially in the offshore. Biomarkers are also especially valuable for diagnosing unanticipated health effects, and providing information on their geographical reach. ICES and other agencies

have been a major driving force for use of indicators in biological monitoring and such indicators are being used extensively in various countries. It is also important to note that biomarkers are a powerful tool for providing assistance in "disproving" as well as "proving" whether contaminants may be having effects on fish health. For instance, perceptions or concerns about population-level effects around oil development sites would have little scientific credibility in the absence of no or limited evidence for early warning health effects.

It should be noted that the fish health and tainting studies on the Grand Banks were implemented along with other components after considerable consultation and input by advisory groups and workshops. Fish health and tainting components were specifically included so that regulators and industry would be in a position to address any questions arising in these two important areas.

Transplanted mussels can provide general information on water quality, but they are of limited value or ecological relevance for addressing questions on whether fish health in and around the production platform is being affected or not. Sediment and water chemistry can often provide more useful information in this regard. Furthermore monitoring of toxic effects on mussels can be greatly confounded by the effects of suspended particles. If mussels, scallops, lobsters, etc. are found naturally in the area, there could be valid scientific and/or socio-economic reason to assess potential zones of impact on these species.

Plume validation in itself is always a useful exercise but may be of limited value unless an extremely large sampling program is carried out over a fairly broad geographic area at varying distances in the water column and under different wind conditions. Information on chemical concentrations alone would have limited biological value since there are no dose-response studies available to translate into potential effects on the health of fish or other organisms. Thus, one will still have the "so what" question in relation to potential biological effects and field work for effects will still be required.

Overall, continuation of 2005 fish health studies is recommended, particularly since MFO activity was noted to be higher in fish around the site at this time. This induction was small but cod do not typically display large levels of induction on exposure to production water and petroleum so this initial observation might be providing an important signal in relation to potential chronic effects. Bile can be collected for hydrocarbon metabolites as a "cross reference" for MFO. It is important to note that MFO and the various types of liver and gill histopathologies cover a spectrum of exposure time frames.

If age and fish condition are to be measured, a decent sea-balance and stable platform would be required for "small fish" but large fish can be reliably assessed for any significant difference in fish condition. Liver volume rather than weight could be assessed before sample fixation for histology. Gonad volume could also be assessed if they are not running. However, logistics at sea can be difficult and fish condition and age will give a pretty good idea of important morphometrics, with the biomarker and histopathology studies presenting a greater overall scientific reliability on whether platform related effects are occurring in fish at the site.

## Proposed 2007 EEM Monitoring Plan

Some parameters that were not measured in 2006 are proposed to be monitored in 2007 (e.g., mussel body burden). Marine mammals and fish health would not be monitored in the current proposal. As with 2006, no monitoring within the Gully MPA is currently proposed. Given that there is no sediment monitoring at any locations, it is unclear how potential long-term or

cumulative effects of ExxonMobil's offshore petroleum activities on the Gully MPA could be modeled or extrapolated from the current monitoring activities.

It is recommended that discussions be initiated with DFO about possible opportunities for collaborative sampling and/or analysis of sediment samples near SOEI and/or in the Gully MPA in 2007. Recommendations on fish health sampling, benthic habitat and fish density, and produced water toxicity are outlined in previous sections.

It is nice to see that mussels for mussel body burden will be sampled on the 'downstream' jacket leg as recommended previously; however, this may limit comparison with 2005 sampling results.

## Conclusions

In general, the 2006 SOEP Offshore Monitoring Program results were presented in a descriptive and easy-to-read format; however, they appear to be of limited value for evaluation of the short-term effects of petroleum production at Thebaud and may be of limited value in future analysis of longer-term and cumulative effects of SOEI operations. However, it is hoped that these results can be used to make improvements to the program proposed for 2007 and future EEM programs. Improvements might include: the use of standardized benthic sampling locations; use of more quantitative and statistically meaningful design, sampling and analysis techniques; more meaningful bioassay tests; and better graphic representation of results.

It is recommended that efforts be made in 2007 to monitor sediment quality (either independently or in collaboration with DFO) and fish health in addition to those parameters already identified within the proposed 2007 EEM program. It is also recommended that opportunities for conducting ongoing marine mammal observations and opportunities for collaborative research and monitoring in the Gully MPA be explored.

Finally, SOEI is encouraged to develop plans/template for a more detailed analysis and presentation of its monitoring results. Plans for this type of detailed analysis should be developed as soon as possible to ensure that meaningful results are being provided by the monitoring design; however, it is expected that such a detailed report might only be provided every 5 years or so.

## Contributors

| | |
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| Jae Choi | DFO Maritimes Science |
| Norm Cochrane | DFO Maritimes Science |
| Ken Lee | DFO Maritimes Science |
| Jerry Payne | DFO Newfoundland & Labrador Science |
| Mark Showell | DFO Maritimes Science |
| Tana Worcester | DFO Maritimes Science (Author) |

## Approved by

Michael Sinclair
Regional Director, Science
Dartmouth, NS
(902) 426-3490

## Sources of Information

AMEC, and Hurley Environment Ltd. 2007. 2006 Annual Report Offshore Environmental Effects Monitoring Program. Submitted to ExxonMobil Canada Properties – Sable Offshore Energy Project by AMEC and Hurley Environment Ltd. on behalf of ACCENT Engineering Consultants Inc.

## This Report is Available from the:

Center for Science Advice (CSA)
Maritimes Region and Gulf Region
Fisheries and Oceans Canada
P.O. Box 1006, Stn. B203
Dartmouth, Nova Scotia
Canada B2Y 4A2

Telephone: 902-426-7070
Fax: 902-426-5435
E-Mail: XMARMRAP@mar.dfo-mpo.gc.ca
Internet address: www.dfo-mpo.gc.ca/csas



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## Correct Citation for this Publication

DFO, 2007. Review of Exxon Mobil Canada's 2006 Offshore Environmental Effects Monitoring Report. DFO Can. Sci. Advis. Sec. Sci. Resp. 2007/007.