Open Water Peer Review Panel
Monitoring Plan Recommendations Report – SHELL BEAUFORT

After discussion and review of Shell's marine mammal monitoring plan for its proposed Beaufort Sea (Camden Bay) operations in the summer of 2012, panel members have answered the questions below set forth by the National Marine Fisheries Service's Office of Protected Resources (OPR) and provide the following recommendations. Answers to, and recommendations based on, the specific questions were developed using the general monitoring requirements outlined in the Marine Mammal Protection Act (MMPA) implementing regulations and further guidance provided by OPR, which were included in the Instruction document and have been copied into this document below the questions.

This monitoring plan had three general elements: vessel-based monitoring, aerial survey program, and acoustic monitoring. Each element is assessed relative to four questions regarding objectives, assessed efficacy, and potential modifications. Additionally, the panel's views on the best way to report monitoring results are considered in general and with reference to each monitoring element, as appropriate. The 2010 Open Water Meeting Peer Review Panel reviewed this plan and provided a number of specific suggestions. The oil and gas operations originally planned for 2010 were not conducted in 2010 or 2011 and the proposed operations for 2012 are the same as proposed for 2010. However, Shell's monitoring plan has changed, indicating that the company clearly responded to the previous panel's recommendations and made substantial and important improvements in their proposed monitoring approach.

Questions

I. Will the applicant's stated objectives effectively further the understanding of the impacts of their activities on marine mammals and otherwise accomplish the goals stated above? If not, how should the objectives be modified to better accomplish the goals above?

Vessel-Based Monitoring

The stated objectives are:

- to ensure that disturbance to marine mammals and subsistence hunts is minimized and all permit stipulations are followed;
- to document the effects of the proposed exploratory activities on marine mammals; and
- to collect data on the occurrence and distribution of marine mammals in the study area.

Vessel-based monitoring will rely on marine mammal observers (MMOs) for two objectives. The first is to detect marine mammals that are within or are about to enter 180 dB or 190 dB safety zones (depending on the species involved) where they might be exposed to excessive levels of

sound that could result in more than Level B harassment. The second is to collect observations of marine mammals outside the safety zones but within zones where they may be exposed to sufficient sound to result in significant behavioral changes. The stated objectives for the vessel-based monitoring program are generally appropriate and Shell is planning to implement them in a manner consistent with standard industry practice. In fact, Shell will be using MMOs on all its vessels. For that reason, the observer program will be consistent with what might call "best practices."

That being said, vessel-based monitoring, as implemented in these circumstances, suffers from a number of important shortcomings that are relevant to determining impacts.

- First, the efficacy of observations is generally undetermined. That is, the probability that the observers will detect a marine mammal that is in a safety zone may be relatively high for some species but low for others, but in no case is the actual efficacy known with a specific degree of confidence.
- Second, observations become less efficient to the point of being completely ineffective as sighting conditions deteriorate (*e.g*., nighttime, high sea state, poor weather).
- Third, visibility is may be adequate for safety zones but the ability to sight animals declines with distance and disturbance of animals beyond sighting distance may go undetected.
- Fourth, it is difficult to characterize animal responses because observers are not able to focus on animal behavior without compromising their likelihood of observing other animals in the area.

Based on these shortcomings, it is not possible to estimate the number of animals taken with reliable degrees of confidence. In essence, these are not scientifically rigorous surveys, but rather preventative measures of underdetermined efficacy. They should not be used or considered to constitute baseline estimates of the numbers of marine mammals in the area. Although there may be no immediate remedy for these shortcomings that can be implemented to improve the utility of vessel-based monitoring, each of the above described shortcomings should be evaluated more closely in the future with the overall aim of characterizing and improving MMO efficiency over time.

The one objective with which the panel takes some exception is the intent to ensure that disturbance to the subsistence hunt of marine mammals is minimized. The panel discussed the idea of whether proposed operations will affect the availability of marine mammals to subsistence hunters. It concluded that "availability" is not just a function of number and location of animals, but also their behavior. Thus, bowhead whales may be present but may not be available if they become more skittish because of the proposed operations. Whether the whales (or other species) change their behavior might best be judged by the subsistence hunters, and they should be consulted at the end of the season to determine if they have observed such changes over the course of the proposed activities, with some effort to control for their knowledge of the specific time course of operations.

Aerial Survey Program

The objectives are:

- to advise operating vessels as to the presence of marine mammals (primarily cetaceans) in the general area of operation;
- to collect and report data on the distribution, numbers, movement and behavior of marine mammals near the exploration drilling operations with special emphasis on migrating bowhead whales;
- to support regulatory reporting related to the estimation of impacts of exploration drilling operations on marine mammals;
- to investigate potential deflection of bowhead whales during migration by documenting how far east of exploration drilling operations a deflection may occur, and where whales return to normal migration patterns west of the operations; and
- to monitor the accessibility of bowhead whales to Inupiat hunters.

The aerial survey program is particularly important because it compensates for the inability of vessel-based MMOs to assess distant (*i.e.*, far field) change in behavior. The objectives for the aerial survey program are seen as largely appropriate and sufficient to enable Shell to meet their permit requirements and assess impacts around operations. The first objective to advise operating vessels about the general presence of marine mammals in the operating area is somewhat vague and recommends that Shell have an explicit plan for how this will be accomplished (e.g., through daily team briefing). Additionally the same comment as above for vessel-based MMOs is applicable to objective #5 given for the aerial survey program – these observations can confirm the presence of marine mammals in the operational area, but cannot confirm availability or accessibility to hunters.

Acoustic Monitoring Program

The objectives are:

- to quantify the absolute sound levels produced by drilling, and to monitor their variations with time, distance and direction from the drilling vessel;
- to measure the sound levels produced by vessels operating in support of exploration drilling operations. These vessels will include crew change vessels, tugs, ice management vessels and spill response vessels; and
- to measure the sound levels produced by an end-of-hole ZVSP survey using a stationary sound source.

The stated objectives for the archival and real-time acoustic monitoring of drilling operations, vessel operations, and of the ZVSP survey are appropriate and enable Shell to meet their monitoring requirements in a manner consistent with standard practices. As described in greater detail below, the panel feels that Shell has developed an excellent capability to monitor

sound levels and variance in time and range from these operations, but is more limited in terms of measuring the spatial variance (directionality) of resulting sound fields. As will be described more generally, it also is important to start considering alternative ways of characterizing the full soundscape in the area of the operations rather than relying solely on limited measures or aspects of it.

II. Can the applicant achieve the stated objectives based on the methods described in the plan?

Vessel-Based Monitoring

Generally, these objectives can be met with the methods proposed, given that the objective regarding reducing impacts to the subsistence hunt is revised as described above. And, again, it should be noted that Shell has improved the monitoring plan substantially since it was presented in 2010 (*e.g.*, use of big-eye binoculars where appropriate, use of native MMOs, GIS-based operational visualization capabilities). In particular, Shell should be commended for the committing to use MMOs on every vessel, including the use of two trained MMOs per shift on sound source vessels.

That being said, the panel believes Shell can achieve their stated objectives most effectively if they ensure the following conditions.

(1) Ensure that that the MMOs on duty MMOs have the power to implement required mitigation measures (*e.g.*, slow down or diversion of the ship based on a sighting) irrespective of operations underway unless those measures would pose a risk to human safety or increase substantially the risk of an accident with potentially serious complications.
(2) Within safe limits, the MMOs should be stationed where they have the best possible viewing. Viewing may not always be best from the ship bridge, and in some cases may be best higher positions with less visual obstructions (*e.g.*, flying bridge).
(3) The MMOs should be instructed to identify animals as unknown where appropriate rather than strive to identify a species if there is significant uncertainty.
(4) Finally, sampling of the relative near-field around operations must be corrected for effort to provide the best possible estimates of marine mammals in safety and exposure zones.

Aerial Survey Program

As with vessel-based MMOs (and given the modification of objective #5 regarding subsistence hunts), the proposed approach is seen as appropriate and adequate to meet the stated objectives; a few minor modifications are suggested under question III below. As with any aerial survey program, the extent to which these efforts are effective is dependent on whether conditions (*e.g.*, weather) are sufficient for flying. By combining three methods involving

MMOs on vessels, acoustic monitoring, and aerial surveys, Shell appears to have provided means for compensating for poor flying conditions.

Shell also made a number of important improvements since 2010. These include the use of line transect instead of strip transect data, the integration of that data directly into a computer database, and the modification of survey lines based on a power analysis suggested by the 2010 peer review panel. The results of the power analysis provide an opportunity for Shell to tailor their surveys depending on circumstances (*e.g.*, the presence and numbers of animals, the distance at which deflection occurs). While not seen by the panel as a significant augmentation of their current monitoring effort given the exploratory nature of this approach, the pairing of still and HD video cameras along with human visual observers on aerial surveys is seen as a positive development to test the efficacy of photographic analysis methods.

Acoustic Monitoring Program

The proposed measurements of sounds associated with drillship operations, all operational vessels (including drill ships in transit mode), and the zero-offset vertical seismic profile (ZVSP) surveys are adequate and appropriate to meet the stated objectives of measuring sound levels and variations in time and distance from sound sources. For sound source characterization and verification efforts Shell is using appropriate monitoring equipment and technical personnel with a proven track record for making these kinds of measurements accurately. In addition, Shell plans to conduct real-time monitoring from one sensor during all operations to provide a continuous record of the sound field and a basis for modifying safety and exposure zones according to operations; this is a positive development.

However, the panel questions whether the proposed monitoring approach (*i.e.*, using a single line of sensors at discrete ranges (500, 2000, 4000, 8000m) from the drilling rig and the two recorders (with 200m spacing) for the vessel source characterization) is sufficient to measure reliably the directionality of the associated sound fields. Minor modifications and additions to the spatial sampling should provide a more robust measurement of radiated sound fields as well as the resulting directionality and isopleths for zones associated with mitigation measures (*e.g.*, shut-down zones) (discussed below).

The directional autonomous seafloor acoustic recorder (DASAR) arrays described in the Shell presentation have and will continue to provide important data on marine mammals and their presence near oil and gas operations. These are an important part of Shell's monitoring plan and will support their ability to meet their stated objectives. The rearrangement of the DASARs and addition of targeted triplets around the (changing) location of drilling operations is a logical and welcome approach. The panel also notes the deployment of additional DASARs in 2010 and 2011 in sites near the proposed drilling locations to obtain baseline acoustic data.

III. Are there technical modifications to the proposed monitoring techniques and methodologies proposed by the applicant that should be considered to better accomplish their stated objectives?

Vessel-Based Monitoring

Shell has clearly modified and improved its the vessel-based MMO program since 2010. Nonetheless, the effectiveness of MMOs could be improved in several ways (several of which have already been mentioned):

(1) The MMOs should be stationed where they have the best possible view of the areas to be scanned.
(2) The MMOs should maximize their time with eyes on the water. To this end, the MMOs should:
    (a) record species as unidentified if their identity is not readily apparent;
    (b) use data recording systems that do not involve long distractions from observing;
    (c) In instances where the observer is also the data recorder, some additional means of data collection (*e.g.*, audio recorder) should be used to allow the MMO to maintain visual contact with the water.
(3) GIS-based software programs may provide a more effective basis of recording the location of observed animals.
(4) Where multiple vessels are operating, real-time communication among MMOs on different vessels should be useful for minimizing risks to marine mammals in the operation area.
(5) Continued testing and development of night-vision technology appears to be the most promising way of detecting marine mammals at night.

Finally, the panel believes that MMOs should not work for the development company *per se*, as such arrangements may lead to unnecessary conflicts of interest, or the appearance of such. Therefore, the panel encourages a greater degree of independence for hiring, training, and debriefing MMOs in a manner that maintains their independence from the developer.

Aerial Survey Program

The proposed line-transect methods are a clear improvement over the previous monitoring plan and the spatial coverage proposed is adequate and should be sufficient for detecting large-scale changes. Nevertheless, the panel believes, some slight modifications/clarifications to the proposed plan would be helpful. First, unless there are specific requirements in the final IHA to detect cow/calf pairs or large aggregations of bowhead whales, aerial surveys in the Shell program should maintain line transects and not circle to verify cow/calf pairs: the number of cow/calf pairs in the area should be based on BWASP surveys, which routinely do circle sightings to confirm group size and composition. Additionally, the panel questions the proposed approach of always flying west-to-east and questions whether such an approach might bias sampling, particularly for the purpose of detecting bowhead deflection. The panel

suggests that, conditions allowing, the direction of flight be determined randomly; a randomized approach to where to start flying line transects is suggested. Finally, in terms of the experimental use of photography and video to augment human observers in aerial surveys, the panel emphasizes the use of similar methods and equipment throughout the season to ensure data consistency and comparability. The panel also recommends that, if the aircraft is able to fly at 1000ft or below, the surveys always use 20 mm lenses (rather than 100 mm) to ensure an adequate strip width.

Acoustic Monitoring Program

For both sound source characterization and sound source verifications, the panel suggests a more robust spatial sampling scheme to provide more accurate noise footprints. Additional DASAR deployments might foster better directional measurements of radiated noise, but a relatively minor addition of sensors should provide a better basis for characterizing the noise footprint. Specifically, the panel suggests that additional deployments of the sensors at variable ranges (on at least one additional axis) to provide a better validation of the spatial propagation patterns of noise around operations. This could include a combination of data from DASARs, the planned line array, and additional deployed sensors or hydrophones strategically deployed from vessels.

More sophisticated propagation modeling was done for the drill ship than for the ZVSP and ice management; diagrams showing predicted isopleths rather than just range to specific received levels and more robust calculations are needed for ZVSP and ice management operations. Once source characterization and sound source verification measurements are obtained (including better resolution regarding directionality), propagation models should be rerun to provide better spatial footprints on which to base mitigation zones.

Finally, the panel suggests that if a mitigation gun is used during the stationary ZVSP surveys around the drilling sites, its duty cycle be reduced (*e.g.*, 1 shot/min) would be appropriate. The panel recognizes that this is an operational/mitigation measure rather than a specific aspect of the acoustic monitoring plan,, but a reduced duty cycle would lessen the energy going into the water while still maintaining an acoustic presence of operations between firings of the full array.

IV. Are there techniques not proposed by the applicant (i.e., additional monitoring techniques or methodologies) that should be considered for inclusion in the applicant's monitoring program to better accomplish their stated objectives?

Vessel-Based Monitoring

As is the case for night-time observations, the panel encourages use of the best available technology to improve detection capability during periods of fog and other types of inclement weather. Such technology might include night-vision goggles or binoculars as well as other

instruments that incorporate infrared technology. It would also be useful to apply appropriate statistical procedures for probability estimation of marine mammals missed, based on observational data acquired during some period of time before and after night or fog events.

Aerial Survey Program

No additional novel techniques are proposed. The inclusion of high-resolution still photography and high definition video in conjunction with human visual observers on planes is a significant new technological approach already proposed by Shell. The panel welcomes this proposed experimental approach and looks forward to the results of the comparative analysis.

Acoustic Monitoring Program

No additional techniques are suggested; modifications/iterations of existing methods are suggested for acoustic monitoring under question III above. The panel notes that the Shell acoustic receivers in Camden Bay may be able to detect seismic signals from offshore shooting in the BP Simpson Lagoon surveys – these data should be available and assessed relative to BP operations and in terms of any animal observations made during the course of Shell's monitoring efforts. The panel also suggests that Shell consider the potential integration of visual and acoustic data from DASARs to generate estimates of bowhead and walrus density using methods developed in the DECAF project by the Center for Research into Ecological and Environmental Modeling (CREEM) at the University of St. Andrews in Scotland.

V. What is the best way for an applicant to present their data and results (formatting, metrics, graphics, etc.) in the required reports that are to be submitted to NMFS (i.e., 90-day report and comprehensive report)?

The panel feels it is important that the required reports are useful summaries and interpretations of the results of the various elements of the monitoring plan as opposed to merely regurgitations of all of the raw results. They should thus represent a first derivative level of summary/interpretation of the efficacy, measurements, and observations rather than raw data or fully processed analysis. They should include a clear summary timeline and spatial (map) representation/summary of operations and important observations. Any and all mitigation measures (*e.g.*, vessel course deviations for animal avoidance, operational shut-down) should be summarized. Additionally, they should include an assessment of the efficacy of monitoring methods.