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

After discussion and review of Shell's marine mammal monitoring plan for its proposed Chukchi Sea 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 approaches to the reporting of results from the monitoring plans are considered in general and with reference to each monitoring element, as appropriate. The 2010 Open Water Meeting Peer Review Panel reviewed an earlier version of this plan and made a number of specific suggestions to improve it. The operations planned for 2010 were not conducted in 2010 or 2011 and the current monitoring plan is similar to that proposed in 2010. However, a number of changes were made in response to the recommendations from the 2010 panel. Most notably, Shell is planning an aerial survey program for the offshore areas in the Chukchi Sea around Shell's Burger prospect; it will use an experimental approach involving photography/video rather than human observers. Clearly, Shell has responded to previous suggestions and made 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 for the vessel-based monitoring program are "to ensure that disturbance to marine mammals and subsistence hunts is minimized, that effects on marine mammals are documented, and to collect data on the occurrence and distribution of marine mammals in the project area." With several caveats, these objectives are generally acceptable and should help Shell accomplish its goals. The caveats are as follows. The first objective should not be simply to ensure that disturbance to marine mammals and subsistence hunts is simply "minimized" because even when minimized, the effects could be more than negligible on a marine mammal population and could result in unmitigable adverse effects on the availability of marine

mammals for subsistence purposes. In accordance with the Marine Mammal Protection Act, the effects should be no more than negligible, the least practicable, and mitigable with regard to their impact on the subsistence harvest.

The second caveat pertains to the collection of data on the occurrence and distribution of marine mammals in the project area. Arguably, this objective is too vague inasmuch as reporting the presence of just a few animals in the project area would technically meet this objective. Rather, the objective should be to provide reliable, statistically robust estimates of the marine mammals in the project area, their distribution and movement patterns, and evidence sufficient to determine if, and if so how, project operations affect their presence, distribution, and movements.

With regard to the second caveat, the vessel-based monitoring plan will provide useful information, but that information will not meet the standards of rigorous scientific surveys. Importantly, the results should not be viewed as providing baseline information on the marine mammals in the area. That being said, the vessel based monitoring plan should be helpful, particularly for the purpose of mitigating potential interactions between project vessels and marine mammals.

Aerial Survey Program

The aerial survey program objectives in 2012 will be to:

- collect data on the distribution and abundance of marine mammals in coastal areas of the eastern Chukchi Sea; and
- collect and report data on the distribution, numbers, orientation and behavior of marine mammals, particularly beluga whales, near traditional hunting areas in the eastern Chukchi Sea.

The objectives of the aerial survey program described in the monitoring plan submitted with Shell's Chukchi IHA application pertained to coastal areas through which aspects of their operations transit, but not overlapping with areas of proposed exploration drilling. The objectives for this ongoing coastal aerial survey program are appropriate and will contribute to Shell's efforts to meet their permit requirements and assess impacts of aspects of their operations (essentially vessel transit) in coastal areas of the eastern Chukchi Sea. The coastal survey should be particularly helpful in evaluating concerns that oil and gas activities will interfere with subsistence hunts, particularly for beluga whales.

Additionally, at the peer review panel presentation Shell indicated that they intend to conduct additional aerial survey effort in the areas where proposed exploratory drilling and ZVSP seismic activities will occur (within the Burger prospect). These surveys will not involve human observers, but rather will involve the use of high resolution photographs and high definition video from airplanes flying line transects. This is the first time this type of approach will be used in the Chukchi. However, the planned approach is experimental and it is not yet clear that it will provide results comparable to surveys using human observers. Until the results of this

approach are reviewed and compared directly with results from human observers (as Shell plans in Beaufort Sea-Camden Bay operations for 2012), these efforts should be seen as purely exploratory. That being said, the panel welcomes this addition to the overall monitoring plan and believes that it has the potential to be useful in meeting monitoring objectives, pending testing and evaluation.

Acoustic Monitoring Program

The monitoring plan notes that "[e]xploration drilling sounds are expected to vary significantly with time due to variations in the level of operations and the different types of equipment used at different times onboard the drillship." The plan therefore set the goals of its acoustic monitoring plan to be to:

- quantify the absolute sound levels produced by exploration drilling and to monitor their variations with time, distance and direction from the drillship;
- measure the sound levels produced by vessels operating in support of exploration drilling operations (including crew change vessels, tugs, ice management vessels, and spill response vessels); and
- measure the sound levels produced by an end-of-hole zero-offset vertical seismic profile (ZVSP) survey using a stationary sound source.

These objectives are appropriate and should enable Shell to meet their monitoring requirements. In essence, Shell's objectives in acoustic monitoring in the Chukchi Sea include direct measurements of sounds around the proposed exploratory drilling operations that are largely similar to the proposed approach in the Beaufort Sea. As described in greater detail below, 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.

Additionally, Shell is supporting deployments of acoustic arrays as part of a multi-partner Joint Science Program to measure ambient noise and biological acoustics across wider areas of the Chukchi Sea. The broader program appears well positioned to assess large-scale changes in the distribution of several marine mammal species in the area and is occurring over a sufficiently large area and time scale to contribute significantly to the stated objectives of this program.

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

Vessel-Based Monitoring

Vessel-based monitoring will rely on marine mammal observers (MMOs) for two functions. 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 consistent with or exceed industry best practices. For example, Shell will be using MMOs on all its vessels.

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.
- 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. As noted earlier, these are not scientifically rigorous surveys, but rather preventative measures of undetermined 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.

Aerial Survey Program

The methods being used in the coastal aerial surveys are seen as adequate for Shell to meet the stated objectives for this part of the monitoring program. However, the panel feels that these surveys should begin somewhat earlier in the season to detect relevant movements of beluga whales (discussed under III below).

The methods for offshore aerial surveys involving high resolution photographs and video are acknowledged to be potentially promising but untested. Their use in the Chukchi is certainly a positive development, but the efficacy and degree to which this contributes to Shell's objectives will depend on the validation of these results (based on work in the Beaufort Sea). This approach should not yet be viewed as equivalent to traditional aerial surveys using human observers.

Acoustic Monitoring Program

The proposed measurements of sounds associated with drillship operations, all operational vessels (including drill ships in transit mode), and the 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 the 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. Shell also plans to conduct real-time monitoring from one sensor in different operational modes to characterize the sound field on a continuous basis. Such information can be used to modify safety/impact zones according to operations; this is a positive development.

However, the panel questions whether, with the proposed monitoring approach 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 provides a basis for adequately measuring the directionality of the associated sound fields. With minor modifications and additions to the spatial sampling, a more robust measurement of radiated sound fields, and the resulting directionality and isopleths for zones associated with mitigation measures (*e.g.*, shut-down zones) could be better accomplished (discussed below).

Regarding modifications to the acoustic net arrays in Chukchi Sea, the panel has some concerns about the reduced capability to localize sound sources (and resulting reduced ability to assess the distribution of vocalizing animals) given the (necessary) spacing out of the elements to avoid masking from proposed drilling operations. That the company has to adjust their deployments to avoid masking from drilling operations underscores the potential for masking of communication sounds for animals in the area and the need for both the companies and NMFS to more explicitly measure and assess these impacts. Although the spacing of some elements further away from the development site is understandable and appropriate, the loss of resolution on animal positions undermines the monitoring effort. Given that the aerial survey effort in the offshore areas around the development site is a new and as yet untested method, the acoustic monitoring methods should be as precise and robust as possible. Consequently, the panel recommends that Shell consider a small increase in the number of elements and position several of the new sensors in small sub-arrays (to include some of the planned deployment sites) to the northeast, northwest, and south of the proposed drilling site. The design of these arrays should be optimized to localize calls over the entire operational area and to permit evaluation of bowhead and beluga tracks where possible (*i.e.*, provide data for ongoing efforts to develop animal tracking algorithms).

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

The panel makes a number of recommendations to ensure the conditions necessary for vessel-based MMOs to meet their responsibilities, including:

(1) Shell should 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.
(5) The MMOs should maximize their time with eyes on the water. This may require new means of recording data or the presence of a data recorder so that the observers can simply relay information to them.
(6) It would be useful if the MMOs or recorders have GIS software available to plot marine mammals sighted and vessel position on a real-time basis.
(7) Shell should develop a plan for real-time, inter-vessel communication of animal positions when multiple vessels are operating in an area.
(8) Further work is needed to improve marine mammal detection capabilities when sighting conditions are poor (e.g., nighttime, high sea states, inclement weather).
(9) Finally, the panel recommends a greater degree of independence for hiring, training, and debriefing MMOs to avoid potential conflicts of interest or the appearance of such; ideally MMOs should be contracted independently from the development company.

Aerial Survey Program

For the coastal aerial surveys, a slight modification in timing is suggested to ensure that Shell has the potential to detect and interpret movement patterns of belugas in and around the operational area. Surveys in previous seasons have typically begun in mid-July, but the panel feels that surveys would likely need to begin around June 25 in order to appropriately study the coastal movements of beluga whales. These surveys should analyze coastal distributions relative to offshore activities, while taking into consideration confounding factors of commercial transport or other vessel traffic, including vessels not associated with Shell's program.

As noted above, the panel welcomes the new effort to conduct aerial surveys in the offshore areas and looks forward to the results of pilot efforts. The efficacy of this approach and

subsequent modifications should be determined from both its use in the Chukchi Sea and (most importantly) a careful comparison of relative performance of photographic versus human observers in Shell's efforts in Camden Bay.

Acoustic Monitoring Program

For both sound source characterization and SSVs, a more robust spatial sampling scheme is suggested to determine realistic noise footprints. It is possible that the additional acoustic deployments (as part of Shell's program and those of the Joint Science Program) could aid in augmenting the directional measurements of radiated noise fields, but it seems that with a relatively minor addition of sensors a better characterization of the noise footprint would be possible. Specifically, the panel suggests that additional deployments of the sensors at variable ranges be conducted (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 other planned acoustic sensor deployments in the Chukchi, 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 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 SSV measurements are obtained (including better resolution on directionality), propagation models should be rerun to provide better spatial footprints on which to base mitigation zones.

Finally, although this is an operational/mitigation measure rather than a specific aspect of the acoustic monitoring plan, the panel suggests that if a mitigation gun will be used during the stationary ZVSP surveys around the drilling sites, a reduced duty cycle (e.g., 1 shot/min) would be appropriate. The purpose of this would be to ensure that there is not more energy going into the water than needed to maintain an acoustic presence of operations in 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?

In the Chukchi Sea, Shell will not be collecting discharge streams and disposing of them onshore. The three visual and acoustic monitoring systems will not provide the information needed to assess the potential impact of physical discharge from exploration drilling operations on marine mammals or their habitat. Toxic chemicals introduced into the water column could pose risks to marine mammals and, subsequently, those who rely on those marine mammals for subsistence purposes. The panel estimates that these risks should be relatively low, but also believes that they should be evaluated. In addition, the risks from such discharge could increase

over time if more oil and gas operations are initiated in the Chukchi Sea. This is an on-going and expanding general concern as offshore industrial activity increases.

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

The panel is aware of no additional technology or methods that could be used for monitoring the impacts of Shell's proposed activities on marine mammals.

Acoustic Monitoring Program

The panel recommended several modifications of existing methods for acoustic monitoring under question III above. The panel also suggests that Shell consider the potential integration of visual and acoustic data from the Chukchi monitoring program and the Joint Science Program to produce estimates of bowhead, beluga, 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. A clear summary timeline and spatial (map) representation/summary of operations and important observations should be given. Any and all mitigation measures (*e.g.*, vessel course deviations for animal avoidance, operational shut-down) should be summarized. Additionally, an assessment of the efficacy of monitoring methods should be provided.