EXPERT PANEL REVIEW
OF MONITORING AND MITIGATION PROTOCOLS
IN APPLICATIONS FOR INCIDENTAL TAKE AUTHORIZATIONS
RELATED TO OIL AND GAS EXPLORATION, INCLUDING SEISMIC SURVEYS,
IN THE CHUKCHI AND BEAUFORT SEAS

Anchorage, Alaska
22-26 March 2010

1. BACKGROUND

On 22-24 March 2010 the National Marine Fisheries Service (Service), working with the Minerals Management Service, sponsored an "Arctic Open Water" meeting in Anchorage, Alaska. The purpose of the meeting (the latest in a series of such meetings) was to review various oil and gas activities, including seismic surveys, site clearance/shallow hazard surveys, and exploratory drilling, with a focus on their potential effects on marine ecosystems in the Chukchi and Beaufort Seas. Much of the meeting focused on analyses of past exploration, monitoring, and research activities, as well as descriptions of proposed 2010 activities by Shell, ConocoPhillips, British Petroleum (BP), and Statoil, as well as ION and TGS, two companies that specialize in seismic surveys. At the time of the meeting, the Service had received six applications for incidental harassment authorizations (IHAs) to take marine mammals incidentally under provisions of the Marine Mammal Protection Act and applicable regulations.

For each of these applications, the Service must make a determination as to whether the proposed activities will have (1) more than a negligible impact on the pertinent protected species or stock, or (2) an unmitigable adverse impact on the availability of such species or stock for subsistence hunting. The Service also must prescribe regulations establishing permissible means of taking and other means of effecting the least practicable adverse impact, as well as monitoring and reporting requirements. The Marine Mammal Protection Act defines "take" to mean "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal." In this instance, the Act defines "harassment" to mean "any act of pursuit, torment, or annoyance which—

> (i) has the potential to injure a marine mammal or marine mammal stock in the wild [i.e., Level A harassment]; or
>
> (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering [i.e., Level B harassment]."

The Service requires monitoring for two purposes. The first is to detect when mitigation thresholds have been met and appropriate responses must be instigated (e.g., monitoring that may lead to a shutdown of an activity if a marine mammal enters a safety zone). The second is to allow a post-hoc analysis of the number of animals that may have been taken during the course of an activity. Thus, the former type of monitoring is used to ensure the least practicable impact, whereas the latter is used to estimate post-hoc just what the impact was based on number and types of takes. Monitoring to achieve these two purposes often requires different field techniques or strategies. The remainder

of this report reflects the views of individual panel members, which were similar in many but not all circumstances (as noted), regarding real-time monitoring for purposes of mitigation and the collection of monitoring data for purposes of informing subsequent assessment of impact.

2. PEER-REVIEW PANEL

The regulations pertaining to issuance of incidental take authorizations also require peer review to evaluate proposed monitoring methods. Section 216.108(d)) (50 CFR) states:

> Where the proposed activity may affect the availability of a species or stock of a marine mammal for taking for subsistence purposes, proposed monitoring plans... must be independently peer-reviewed prior to issuance of an incidental harassment authorization.

To satisfy this peer-review requirement, the Service convened a panel of seven scientists (section 7) with diverse backgrounds but all familiar with marine mammal research and conservation in the Arctic regions of Alaska. On 25-26 March 2010 the panel members reviewed all IHA applications and discussed specific recommendations[1]. Panel members did not strive for consensus and different perspectives will be indicated in the remainder of this report by reference to the views of "some" and "others."

The specific guidance given to the panel was as follows:

> Each IHA [incidental harassment authorization] applicant's monitoring program should document the effects (including acoustic) on marine mammals (e.g., noted reactions of the animals to the activity) and document or estimate the actual level of take as a result of the activity (in this case, either seismic surveys, site clearance/shallow hazard surveys, or exploratory drilling). OPR [the Service's Office of Protected Resources] is asking you to review the monitoring plans to ensure that the monitoring activities and methods described in the plans will enable the applicant to meet these requirements. Additionally, OPR would like the panel to discuss the following questions [paraphrased] with regards to each monitoring plan:
>
> - Are the applicant's objectives achievable based on the methods described in the plan?
> - Are the applicant's objectives the most useful for understanding impacts on marine mammals?
> - Should the applicant consider additional monitoring methods or modifications of proposed monitoring methods for the proposed activity?
> - What is the best way for an applicant to report their data and results to NMFS?
>
> After discussion of the monitoring plans, the panel will submit a recommendations report to OPR that describes the changes (and reasons for the changes) the panel suggests for the

[1] Meeting minutes are available upon request.

> monitoring plans....[T]he report should make clear when a recommendation or comment applies to all monitoring plans versus the instances when a particular recommendation or comment only applies to one applicant's monitoring plan.

The remainder of this document summarizes the major points emanating from the panel's discussions, including those that pertain to all or multiple applications and those that pertain to an individual application.

3. GENERAL RECOMMENDATIONS AND COMMENTS

3.1. Acoustic effects of oil and gas exploration – assessment and mitigation

Much of the panel's deliberation regarding the proposed activities and accompanying mitigation measures focused on the effects of noise on marine life. Perhaps the most important recommendation by the panel members is that the Service begin a transition away from using a single metric of acoustic exposure (i.e., sound pressure level) to estimate the potential effects of anthropogenic sound on marine living resources. Although sound pressure level has been used historically and is relatively simple to apply, the available science increasingly indicates that no single factor is likely to encompass all of the relevant aspects of sound exposure needed to assess, monitor, or mitigate effects. Rather, the effects of anthropogenic sound on marine mammals are determined by the influence of a suite of potentially co-varying physical and biological factors. Important characteristics of sound may include the natural ambient level, the relative difference from ambient noise as a new noise is introduced (the signal-to-noise ratio), the "sensation" level of sound which takes into account both the signal-to-noise ratio and characteristics of receiver hearing capabilities, sound "rise" time (the time required for the sound to reach its peak level) and the relative impulsiveness of the signals, total sound energy received, sound frequency, sound constancy or pattern, and sound duration. Other important physical factors influencing the sound field generated by the industrial activity include the bathymetry, proximity to shore, ocean bottom substrate, and presence of sea ice. Important biological influences may include activity of the animals involved (e.g., feeding, migration, reproduction), their social structure (e.g., aggregations of individuals or presence of mother-calf pairs), their previous individual experience with the sound (i.e., sound novelty, association with predator or prey sounds), and the various other biological stressors affecting them.

Given the above considerations, marine mammals are best understood as living within dynamic acoustic environments that, among other things, vary over time, space, frequency, level, and directionality. The term "spatial-temporal-spectral" variation has been used to indicate the complex and dynamic nature of marine acoustic environments. The term also serves as a reminder that a single sound pressure level or other single descriptive parameter is likely a poor predictor of the effects of introduced anthropogenic sound on marine life. Indeed, science has consistently shown that the single-parameter approach to predicting specific effects of sound exposure is largely untenable and more biologically-realistic ways of estimating impact are needed (e.g., Southall et al. 2007, Clark et al. 2009). That is, further progress in understanding the effects of sound on marine ecosystems will require a more comprehensive approach that recognizes and characterizes the "acoustic scene" or "soundscape" in much the same manner that a full understanding of a terrestrial species requires the study of landscape ecology and the co-varying abiotic and biotic features of its surroundings.

Panel members concurred that the Service should be constantly striving toward a more comprehensive ecosystem-based approach in predicting the nature and severity of environmental risks from industrial activities, including oil and gas development. Many of the tools needed to develop more realistic impact predictions are available now or will be available in the foreseeable future. At the same time, panel members recognized that the Service may not able to implement such an approach for mitigation purposes on a real-time basis. For real-time mitigation, the Service may have to continue relying on simple measures that can be readily applied in the field. However, these simple measures should be based on the more comprehensive ecosystem assessments and they should be precautionary to compensate for remaining uncertainty in potential effects. (For example, the Service could apply different levels of precaution by adjusting risk factors as it does in the calculation of potential biological removal levels for stock assessment purposes.) Furthermore, the Service should tailor those simple measures to the various activities to be conducted (e.g., seismic studies versus exploratory drilling), the environments in which they will be conducted (e.g., deep pelagic versus shallow coastal), and the relevant biological circumstances (e.g., species present, migratory versus reproductive seasons). The Service has started to move in this direction by applying different sound exposure thresholds for intermittent versus continuous noise and for different groups of animals.

Implementing this dual approach of comprehensive assessment and simple real-time mitigation rules will require at least three fundamental changes to the status quo: 1) better planning and coordination of research on the biological and physical environment, 2) more research into human influences on the biophysical environment, and 3) the provision of additional resources for such research. The conceptual basis for moving in this direction is clear and the approach is necessary to provide managers with the information necessary to ensure protection of the marine environment during the course of various industrial activities.

3.2. Aerial surveys

Aerial surveys are a useful tool for collecting real-time information on marine mammal distribution and movements, including responses to sound sources. In the Arctic, in particular, they involve significant costs and a degree of risk, which must be weighed against the costs and risks of other monitoring methods. Shell Oil indicated that it will use aerial surveys in the Beaufort Sea, but not in the Chukchi Sea where proposed activities will occur farther offshore and therefore entail more risk. Panel members recognized the additional risk, but some asserted that such surveys can be conducted safely, such as those being flown by the Service in offshore areas of the Chukchi Sea. For that reason, the panel members concluded that aerial surveys should not be categorically excluded as a research and monitoring tool in the Chukchi Sea. If aerial surveys are not used, then additional monitoring tools (e.g., passive acoustic systems, unmanned aircraft systems) must be further developed, field tested, and implemented to provide the type of information gained from aerial surveys (e.g., species-specific estimates of the number of individuals taken by a particular activity). Without some aerial survey capacity, mitigating impacts in areas beyond the view of vessel-based marine mammal observers (i.e., the visual far-field) will be essentially impossible.

Panel members also concluded that the industry could use the same aircraft for detecting mitigation thresholds (e.g., identifying aggregations or mothers with calves within safety radii) and for estimating the total number of takes using conventional line-transect analysis, but only if analytical methods are adapted accordingly. Monitoring for the former purpose requires that the aircraft be able to break away from pre-determined transects to circle sighted animals and confirm such information as species, number of animals, and group composition. Such breaks in flight pattern are

consistent with "closing mode" line transect surveys, and "[t]here is no intrinsic reason why the observer should stay on the line. If more accurate data can be gathered by moving off the line, then field methods should allow this" (Buckland et al. 2001). However, field protocols for closing mode surveys may lead to biased results if conventional line-transect methods are used to analyze the data. One alternative would be to use adaptive line transect sampling methods, which permit additional survey effort in areas of high animal density (Palka and Pollard 1999). Closing mode surveys have the potential disadvantage of taking longer to complete, but if sufficient survey effort can be achieved and analytical methods are adapted accordingly, then closing mode line transect surveys are considered consistent with best practices for the type of broad scale surveys that might be used to estimate total take.

That being said, panel members questioned the design of some aerial surveys proposed in the IHA applications to detect the effects of certain activities (e.g., seismic surveys, exploratory drilling). The frequently used approach of equally spaced and widely dispersed transect lines centered over offshore operations is not appropriate when the primary concern is the response of animals in close proximity to the activity. In such cases, those responsible for monitoring should adjust their survey design (e.g., stratify levels of effort) to meet the monitoring goals, with anticipated level of survey effort determined by pre-survey analyses of statistical power for detecting responses.

Finally, the technology now available for conducting aerial surveys is vastly improved over that used in the recent past. The new technology makes it possible to enter and visualize survey results in real-time, and to combine that information with real-time data from acoustic buoys. All such data provides useful information for those conducting surveys and those responsible for ensuring mitigation thresholds are effectively monitored. To take advantage of such information and maximize the value of aerial surveys for mitigation, survey data should be entered into a computer on board the aircraft in a way that enables immediate geospatial analysis by the survey team and evaluation by the Service. If necessary, the information could then be used to implement mitigation measures for the "activity footprint" of the larger operation.

3.3. Marine mammal observers

Qualified marine mammal observers (MMOs) are key elements of successful monitoring and mitigation efforts and, as such, their training, competence, consistency, and independence are important considerations in any evaluation of their utility. With regard to MMOs, panel members recommended—

- Observers should be trained using visual aids (e.g., videos, photos), to help them identify the species that they are likely to encounter in the conditions under which the animals will likely be seen.

- Observers should understand the importance of classifying marine mammals as "unknown" or "unidentified" if they cannot identify the animals to species with confidence. In those cases, they should note any information that might aid in the identification of the marine mammal sighted. For example, for an unidentified mysticete whale, the observers should record whether the animal had a dorsal fin.

- Observers should attempt to maximize the time spent looking at the water and guarding the safety radii. They should avoid the tendency to spend too much time evaluating animal

behavior or entering data on forms, both of which detract from their primary purpose of monitoring the safety zone.

- "Big eye" binoculars (e.g., 25 x 150 power) should be used from high perches on large, stable platforms. They are most useful for monitoring impact zones that extend beyond the effective line of sight. With two or three observers on watch, the use of big eyes should be paired with searching by naked eye, the latter allowing visual coverage of nearby areas to detect marine mammals. When a single observer is on duty, the observer should follow a regular schedule of shifting between searching by naked-eye, low-power binoculars, and big-eye binoculars based on the activity, the environmental conditions, and the marine mammals of concern.

- Observers should use the best possible positions for observing (e.g., outside and as high on the vessel as possible), taking into account weather and other working conditions.

- Sightings should be entered and archived in a way that enables immediate geospatial depiction to facilitate operational awareness and analysis of risks to marine mammals. Real-time monitoring is especially important in areas of seasonal migration or influx of marine mammals. Various software packages for real-time data entry, mapping, and analysis are available for this purpose.

- Observer teams should include Alaska Natives and all observers should be trained together. Whenever possible, new observers should be paired with experienced observers to avoid situations where lack of experience impairs the quality of observations.

- Following the model used to monitor commercial fisheries, observers should be managed by an independent organization that trains and assigns them to observe various operations. Training and on-site performance should be evaluated regularly. At the end of every assignment, the organization should debrief the observers, collect their data, conduct basic analyses with the data, and prepare the data and results for dissemination to interested parties.

- The Service should provide instructions regarding the estimation of the number of takes during the course of an activity (e.g., seismic survey). The guidance should be sufficiently specific to ensure that take estimates are accurate and include realistic estimates of precision and bias.

3.4. Visual near-field monitoring

For the purposes of this report, panel members used the term "visual near-field monitoring" to refer to visual monitoring of areas within the line of sight, generally the line of sight of MMOs on-board vessels. Visual searching of such areas is one of the most common forms of monitoring, both for mitigation purposes and for estimating the total number of animals taken during an activity. For example, one of the main purposes of MMOs is to implement mitigation measures, especially those intended to avoid the risk of hearing impairment, either temporary or permanent, if marine mammals are too close to a sound source.

Although such monitoring pertains to areas "within the line of sight," it is still subject to limitations and must be corrected for availability and perception biases. For example, visual observers can

detect marine mammals only when they are at the surface (i.e., available for sighting). Furthermore, observers may not detect the marine mammals even when they are at the surface and in view (i.e., they are not perceived). Both of these biases (availability and perception) can vary substantially with environmental conditions. Without suitable corrections, surface observations are inadequate for detecting or estimating the total number of animals that are encountered during a survey.

At least three approaches have been used to improve visual near-field monitoring. The first involves various technologies such as night-vision binoculars and forward-looking infrared devices. Although these technologies may provide a slight increase in detection capability under ideal conditions, the Service should not consider these technologies reliable until they have been tested under appropriate conditions and their efficacy has been evaluated.

A second approach is to "sample" the visual near-field area periodically and then extrapolate to the full survey period. However, this approach also has severe shortcomings. First, visual sampling is extremely difficult at night, but a strategy that avoids any type of nighttime sampling is likely misleading because it disregards the temporal variability inherent in marine mammal behavior. Second, intermittent sampling may be inadequate for detecting events that are relatively rare but may be significant. For these reasons, intermittent sampling only when sampling conditions are optimal may result in biased results and conclusions regarding the effects of industry activities.

With such concerns in mind, the panel discussed a third approach, which is the use of towed passive acoustics arrays to collect information on the occurrence of animals around an observation vessel. Based on those discussions, several panel members recommended that the Service encourage the industry to consider the use of seismic streamers to collect bioacoustic information. At present, this kind of monitoring has not been successfully used for determining the exact locations of animals relative to safety zones, but further development of passive acoustic technology may facilitate such uses in the foreseeable future.

Finally, visual near-field monitoring, coupled with other monitoring approaches (e.g., passive acoustic monitoring) provides a mechanism to evaluate one of the most common industry assumptions pertaining to mitigation—that animals near a sound source will move away as received sound levels increase or are "ramped up." Although ramp-up procedures are commonly included among industry mitigation measures, scientists disagree as to their utility. Collecting the data to test this hypothesis is certainly feasible, but the peer-reviewed scientific literature contains relatively few analyses of such data. To help evaluate the utility of ramp-up procedures, the Service should require observers to record, analyze, and report their observations during any ramp-up period. The Service also should support specific studies using multiple types of monitoring (visual, acoustic, tagging) to evaluate how marine mammals respond to increasing received sound levels. Such information should provide useful evidence as to whether ramp-up procedures are an effective form of mitigation.

3.5. Visual far-field monitoring

For the purposes of this report, panel members used the term "visual far-field monitoring" to refer to the areas beyond line of sight, generally the line of sight of MMOs on-board vessels. Scientists that conduct visual surveys for marine mammals, whether from vessel or aircraft, have long recognized that the probability of detection declines with distance from the survey platform. Monitoring of the far-field is important if animals beyond line of sight are exposed to sound levels that may lead to significant effects, such as masking or changes in important behaviors. Under

certain circumstances (e.g., darkness, rough sea state, inclement weather), the line-of-sight distance also may be reduced to the point that undetected animals could be at risk of hearing impairment, either temporary or permanent.

With that concern in mind, the panel considered three recommendations. The first is that observers carefully document visibility during observation periods so that total estimates of take can be corrected accordingly. The second is that aerial surveys be used whenever possible to supplement the monitoring effort in areas not visible to observers on vessels (section 3.2). The third is that alternative methods be developed to improve monitoring of the visual far-field. In this regard, the most promising method is passive acoustic monitoring. Active acoustic monitoring also may be useful under certain circumstances (i.e., when the risk of injury to animals is high), but is itself a source of additional noise and is therefore a less desirable means of monitoring.

Under ideal conditions, comprehensive monitoring of a large-scale seismic operation would require two to three aircraft, distributed and localized passive acoustic systems to include both real-time and archival units, and ship-based surveys with visual observers, towed passive acoustic monitoring arrays, and active acoustic monitoring systems. Ship surveys could be used in several configurations, including in front of the seismic vessel, adjacent to the airgun array, or behind the array. Tagging of animals expected to be in the area where the survey is planned also may provide valuable information on the location of potentially affected animals and their behavioral responses to industrial activities. Although the panel recognized that such comprehensive monitoring might be difficult and expensive, such an effort (or set of efforts) reflects the complex nature of the challenge of conducting reliable, comprehensive monitoring for seismic or other relatively-intense industrial operations that ensonify large areas of ocean. Examples of far-field monitoring that represent improvements in assessment methods include the BP/Northstar acoustics monitoring project (e.g., Blackwell et al. 2004, 2007; Blackwell and Greene 2006), the monitoring of seismic studies in the Beaufort Sea using aerial surveys in 1992 and 1993 (Schick and Urban 2000) and between 1997 to 1999 (Richardson et al. 1999), and offshore monitoring over the Chukchi Sea using aerial surveys from 1989 to 1991 (Moore and Clarke 1993).

Passive acoustic monitoring provides a valuable tool for far-field monitoring. Despite certain limitations (e.g., it is less useful for animals that rarely vocalize, and it is difficult to extrapolate to population density or abundance), detection rates using passive acoustic methods have far exceeded detection rates based on visual observation in some cases (e.g., Blackwell et al. 2007; Clark et al. *in press*). Overall, passive acoustic monitoring has provided a temporal record of the autumn bowhead whale migration that coincides with that derived from visual sampling (e.g., Moore et al. 1989). In any given set of circumstances, passive acoustic monitoring will require verification using a variety of methods (e.g., visual observers, acoustic and other tags). Nevertheless, it offers the considerable advantage of detecting animals below the surface (which is a substantial impediment to vessel- and aerial-based visual observations), and detecting animals even when visual conditions are poor (i.e., at night or during periods of rough sea state or inclement weather).

3.6. Baseline biological and environmental information

The IHA provisions of the Marine Mammal Protection Act reflect two main concerns, those being that the proposed activities might cause more than negligible impacts on the species or stocks affected, or they might cause unmitigable adverse impacts on the availability of marine mammal species or stocks for subsistence purposes. Determining when an activity has had or will have such effects requires some understanding of natural conditions as a basis for comparison to conditions

that exist during the proposed activities. Panel members considered the collection of baseline information critical for making such comparisons. They noted, however, that the biological information needed to make comparisons often is not available because the necessary background studies have not been conducted. They also noted that collecting such information requires a considerable investment because population status and environmental conditions vary seasonally and inter-annually, and because the Arctic is experiencing directional changes resulting from climate change (e.g., sea ice retreat).

Panel members also noted that information collected on the species or stocks of concern during operations, or during short breaks in operations, cannot be assumed indicative of control or natural conditions without some further form of verification. An animal's behavior during a break in a seismic study or exploratory drilling may not be indicative of natural behavior if the animal's response to previous activity persists into or through the break period or the animal is responding just to the presence of a vessel. For example, if a whale has abandoned disturbed habitat and the source of disturbance has been halted temporarily, the whale's behavior during that halt cannot be assumed to be "natural" unless the whale returns to the habitat where it was initially disturbed. Thus, the notion that industry can collect baseline information during periodic interruptions of its noise-producing activities requires assumptions that have not been tested and likely are not true. It is possible to collect baseline information on species and stocks that may be affected by these operations by conducting studies prior to the initiation of industrial activities or once sufficient time has elapsed after the complete cessation of activities. However, management and research agencies have not yet been willing to commit the necessary resources for the required assessment studies. The panel members therefore recommend that the National Marine Fisheries Service and the Minerals Management Service work with the industry to develop more rigorous, longer-term research methods for collecting baseline information before activities are initiated.

3.7. Comprehensive ecosystem assessments and cumulative impacts

Panel members discussed the need for better analysis of the potentially interacting influences of multiple oil and gas activities co-occurring in time and space and, more broadly, the influences of those activities in combination with ecosystem alterations from climate change (e.g., Moore and Laidre 2006) and coincident with other human activities that are increasing in the Alaskan Arctic (e.g., commercial shipping, fishing, coastal development, military activities, marine recreational activities, scientific research). The concept of "cumulative effects" is recognized in the legislation governing management of marine environments (e.g., National Environmental Policy Act, Endangered Species Act). However, assessments to date are generally inadequate for the purpose of understanding the full effects of human activities on the marine environment. Panel members emphasized the need for more "comprehensive ecosystem assessments" and they used that term to refer to the interaction and collective impact of all human activities and environmental phenomena to which an individual or population is exposed in a well-defined spatial region during a specific period of time. A presentation by R. Day at the Arctic Open Water meeting served as an excellent reminder of the importance of collecting and integrating information on the physical and biological environment. The real challenge appears to be finding ways to integrate and synthesize large amounts of data from multiple sources and/or activities to provide a clearer understanding of the combined influence of multiple human activities on marine life and habitat.

The panel members identified a number of basic tasks that the industry, federal agencies, Alaska Native organizations, conservation organizations, and other interested parties could undertake to promote more comprehensive ecosystem assessments. These include, but are not limited to—

- Emphasize multidisciplinary studies that integrate physical, chemical, and biological measurements to assess human influences throughout marine ecosystems.

- Incorporate data collected using all reliable methods and from all pertinent sources, including broad ecosystem studies, more narrowly targeted research, and other activities (e.g., commercial, military) that may have ecosystem effects. These data streams should be integrated spatially and temporally to provide a more comprehensive assessment of the ecosystem.

- Archive all collected data in standardized databases for sharing among scientific disciplines.

- Maintain and make available detailed logs of all activities in the Beaufort and Chukchi area (e.g., oil and gas, shipping, fishing, scientific cruises, use of ice breakers).

- Develop and implement policies and means for sharing data and ensuring that the research community has access to the information needed to conduct more integrated, comprehensive ecosystem assessments.

- Develop better and more timely methods for integrating and displaying combined datasets spatially and temporally.

- Include data on location and timing of subsistence hunts.

- Monitor developments in other regions or scientific disciplines that may reveal better ways of integrating and analyzing multiple datasets or conducting cumulative effects or comprehensive ecosystem analyses.

- Include pertinent biological information on the status, ecology, and behavior of the potentially affected species or stocks (e.g., contaminant load, body condition, reproduction, distribution, and relative abundance).

3.8. Duplication of seismic survey effort

Panel members briefly discussed the increasing number of geophysical surveys in the Beaufort and Chukchi Seas and whether the essential seismic information could be collected by a coordinated survey effort rather than by independent and sometimes duplicative efforts. Although the risks to marine mammals and marine ecosystems are still somewhat poorly described, unnecessarily duplicative surveys must increase those risks. The fact that some companies are willing to invest in surveys of the region so that later they might sell the resulting data indicates that the information coming from a single survey could well meet the needs of multiple companies. If that is the case, then allowing multiple, duplicative surveys in an area does not appear to meet the standard of having the least practical adverse effect, as required by the Marine Mammal Protection Act. Some members of the panel recommend the Service work with the Minerals Management Service and other relevant stakeholders to promote and possibly require data sharing to reduce or eliminate duplicative seismic surveys in the Alaskan Arctic.

3.9. Whale behavior

On several occasions participants in the Arctic Open Water meeting used the term "skittish" to describe the behavior of whales wary of disturbance. One participant in the meeting raised a question as to the term's specific meaning. Panel members discussed this matter briefly. In essence, skittishness simply means that the animals appear to have become more sensitive to disturbance, responding more quickly and at greater distance from a disturbance source. This change in behavior may mean that the whales are more likely to abandon preferred habitat (e.g., used for reproduction, feeding, migration), with conceivable impacts on survival and reproduction. For Alaska Natives who depend on whales for subsistence, this heightened sensitivity often means that the whales are more difficult to approach and are more dangerous when they are approached.

Such heightened sensitivity of animals to factors that pose threats to them is a well documented and accepted observation in wildlife science. However, determining the cause of such skittishness is another matter. It may reflect the condition of the animals or their physiological state, as well as past experiences including interactions with oil and gas operations, subsistence hunters, vessel traffic (e.g., commercial, fishing), and other human activities in the Arctic. Because multiple factors may contribute to such behavior, studies to characterize the sources for any particular population or species (e.g., bowhead whales, beluga whales) would require a complex research design and considerable resources to gather the required observations.

4. RECOMMENDATIONS AND COMMENTS ON SPECIFIC APPLICATIONS

4.1 ION SEISMIC SURVEY

4.1.1. Each IHA applicant's monitoring program should document the effects (including acoustic) on marine mammals and document or estimate the actual level of take as a result of the activity. Does the monitoring plan meet this goal?

ION's monitoring plan provides limited specific information. The plan would lead to documentation of responses by some animals around the survey vessel, thereby requiring extrapolation to estimate total take. However, ION's strategy also includes an ice-breaking vessel, and the potential effects of that vessel, including the in-air and underwater noise it creates, are poorly understood. The combination of two vessels could have undesirable effects on pinnipeds, in particular: an animal might be frightened off the ice near the vessels and enter the water within a safety zone, potentially exposing it to relatively intense sound levels that could have additional impacts. Furthermore, ION has planned its survey late in the autumn (October to December). During this time, observers will have a very difficult time monitoring marine mammals because of forming sea ice, darkness, and inclement weather. Finally, the plan did not provide sufficient information on how the numerous biases evident in the existing monitoring plan would be quantified. At the end of its deliberation on ION's plan, panel members did not have confidence that their mitigation and monitoring program would provide a reliable estimate of take.

4.1.2. Review the monitoring plans to ensure that the monitoring activities and methods described in the plans will enable the applicant to meet these requirements

For the reasons described above, members of the panel lacked confidence that the monitoring activities and methods were sufficient to meet the objectives.

4.1.3 Are the applicant's objectives achievable based on the methods described in the plan?

The objectives (page 54) can be achieved only partially with the monitoring plan.

Objective 1 – *Ensure that disturbances to marine mammals and subsistence hunts are minimized and all permit stipulations are followed*. This objective can be achieved in part because the survey has been timed to avoid the period when most of the hunting occurs. However, in mid to late October and November substantial numbers of bowheads likely still will be in the Beaufort Sea including near Barrow, which is an important feeding area (Moore et al. 2010, Monnett and Treacy 2005, Lowry et al. 2004). Similarly, surveying from offshore to onshore will help minimize impacts to whales and the subsistence hunt, but will not eliminate such impacts entirely. The distribution of the whales in November is poorly known, although some tagging and acoustic data have been collected.

Objective 2 – *Document effects of the proposed survey on marine mammals*. This objective can be achieved partially, but only for animals that are visible to the MMOs. The monitoring method is entirely dependent on visual monitoring by the MMOs, which is known to be limited by a number of factors that lead to poor visibility (e.g., sea ice, minimal number of daylight hours). The operator did not include plans for acoustic monitoring.

Objective 3 – *Collect baseline data*. This objective cannot be achieved. ION proposed that baseline information can be collected when the seismic airgun is not operating. However, the company also indicated that the full airgun array would be off for only a few hours during the course of the entire survey (a period of several months). Furthermore, the ice-breaker might still be operating when the airgun array is turned off, and such conditions are not representative of a baseline environment.

Finally, some panel members expressed concerns about survey noise from the east causing "skittish" behavior in whales farther west. Such behavior might impact the bowhead hunt at Barrow in October.

4.1.4. Are the applicant's objectives the most useful for understanding impacts on marine mammals?

Yes, the objectives are useful and appropriate.

4.1.5. Should the applicant consider additional monitoring methods or modifications of proposed monitoring methods for the proposed activity?

Yes, ION should—

- Coordinate with other companies (e.g., Shell) that are supporting overwintering buoy studies.
- Consider augmenting existing nearshore acoustic arrays with offshore bottom-mounted acoustic arrays (or single recorders) that would extend recording capability through a larger portion of the area of concern. (Sonobuoys will be difficult to use in heavy ice and may or may not be useful for recording sounds from seismic surveys and marine mammal calls. Bottom-mounted recorders may be more useful for those purposes.)
- Coordinate with other companies or agencies to conduct tagging studies using satellite-linked telemetry. These studies also should integrate information on the amount of sea ice in the

region, and should be analyzed using available programs for describing the distribution and movements of the tagged whales (e.g., kernel analysis).

- Verify calculated safety radii to account for possible sound channels in deeper waters.
- Collect baseline data (with emphasis on acoustic methods) before seismic surveys begin.

4.1.6. What is the best way for an applicant to report their data and results to the Service?

ION should—

- Summarize observation effort and extant visual conditions, the number of animals seen by species, the location and time of each sighting, position relative to the survey vessel, the vessel's activity (i.e., airguns operating or not) at the time, each animal's response, and any adjustments made to operating procedures. It also should provide all spatial data on charts (always including vessel location).
- Make all data (including effort and conditions) available in the report or (preferably) electronically for integration with data from other companies.
- Estimate and report (1) statistical power for all methods intended to detect adverse impacts and (2) uncertainty in all reported estimates (e.g., number of takes).
- Integrate all observer data with information from tagging and acoustic studies to provide a more comprehensive description of the acoustic environment during its survey.
- Accommodate specific requests for raw data, including tracks of all vessels associated with the operation and activity logs documenting when and what types of sounds are introduced into the environment by the operation.

4.2. SHELL DRILLING IN CAMDEN BAY

4.2.1. Each IHA applicant's monitoring program should document the effects (including acoustic) on marine mammals and document or estimate the actual level of take as a result of the activity. Does the monitoring plan meet this goal?

The monitoring plan includes vessel-based MMOs, passive acoustics, and an aerial survey. The plan is likely to meet the goals of documenting effects and providing a basis for estimating the number of takes if Shell monitors the full "footprint" of the operation including the drill rig and associated vessels. If the activity footprint is larger than the area monitored, the monitoring plan will not meet these goals.

The aerial surveys will provide some information on bowhead whale and pinniped distribution. The surveys will not provide species-specific information on seals (including effects of the drilling operation on them), although vessel-based MMOs should be able to do so to some extent (section 3.3).

Panel members discussed two significant concerns regarding the aerial surveys. The first was that a single survey can be used to detect mitigation thresholds and to monitor for the purpose of estimating total effects only if analyses of the data are modified accordingly (section 3.2). Failure to incorporate such modifications could result in highly biased results. The reason for this is that monitoring for mitigation purposes may require that the aircraft break transect to investigate animals sighted and get information on species, number, and composition (e.g., cow-calf pairs). In addition, the time required to make such diversions could prevent a single aircraft from completing its survey of the far-field region as needed to evaluate more long-range effects.

The second concern relates to the design of the survey around the drilling platform. Panel members considered a sampling plan based upon widely spaced transects over a relatively large area to be insufficient to detect deflections in the 5-10 km range. With that concern in mind, panel members recommend that the aerial survey be redesigned to include some level of stratification that would focus more effort in the area where effects are most likely to occur. Some effort is still needed at locations farther away from the drilling operation to document the extent of deflection. Data from previous years should be used to determine the amount of effort required to detect an effect with the desired level of certainty (i.e., a power analysis).

Finally, panel members did not have sufficient information to determine the potential effects of various discharges (e.g., drilling wastes, warm water) around drilling sites and the potential consequences for bowhead whales and other marine mammals in the area.

4.2.2. Review the monitoring plans to ensure that the monitoring activities and methods described in the plans will enable the applicant to meet these requirements

See response to question 1.

4.2.3. Are the applicant's objectives achievable based on the methods described in the plan?

The objectives can be found on pages 2 (vessel-based), 8 (aerial), and 15 (acoustics) of the monitoring plan.

Monitoring in accordance with the plan should provide a good basis for mitigating potential effects as well as for estimating the total number of animals taken. In addition, the plan will result in collection of some baseline information because Shell will be conducting aerial and vessel-based surveys before drilling starts. That baseline information can be supplemented by combining it with data collected in the area during previous years with low levels of industrial activity.

Aerial surveys likely will provide useful information on the presence of marine mammals near the operation if the survey design is modified to focus more effort near the drill ship. The combination of vessel-based MMOs, passive acoustic monitoring, and aerial surveys also should provide a reasonable basis for characterizing the number, distribution, movement, and some behaviors of marine mammals near the area of operation, although each of these methods is subject to limitations (e.g., the aerial survey will not provide species-specific information for pinnipeds). As noted above, the design for the aerial transects should be modified to increase the likelihood of detecting deflections on the order of 5-10 km distance from the drill ship. With such adjustments, the information collected from all these sources should provide a reasonable basis for estimating short-term responses to, and possibly impacts from, this single drilling operation.

Panel members did not have enough information to evaluate Shell's methods for assessing availability of bowhead whales to Inupiat hunters. That is, the present monitoring plan does not provide enough information to determine whether drilling operations will affect either the distribution and number of whales in the hunting area or their behavior. The primary concern with regard to changes in behavior is that the whales may become more "skittish" or wary of human activities, may therefore shift their distribution offshore, may be more difficult to approach, and may be more dangerous when approached. The monitoring plan does not provide an adequate explanation for how such changes in behavior will be evaluated.

The acoustic objectives (page 15) can be achieved with the proposed acoustic monitoring strategy.

4.2.4. Are the applicant's objectives the most useful for understanding impacts on marine mammals?

Panel members felt that the objective "*collect and report data on the distribution, numbers, movement and behavior of marine mammals near the drilling operation, with special emphasis on migrating bowhead whales"* may discount the need to monitor other marine mammals as well. Understanding effects on bowhead whales, whether migrating, feeding, resting, or engaged in any other activity, is important, but other marine mammals also occur in the area, and it is also important to assess potential effects on them and effects on their availability for subsistence purposes.

4.2.5. Should the applicant consider additional monitoring methods or modifications of proposed monitoring methods for the proposed activity?

See above comments regarding simultaneous use of aerial surveys for mitigation and monitoring, the need for stratifying the aerial survey plan to increase coverage closer to the operation where takes are most likely to occur, and the need to compare available datasets (e.g., visual, acoustic) and integrate all available information from this activity and others in the area into a comprehensive ecosystem assessment.

4.2.6. What is the best way for an applicant to report their data and results to NMFS?

Shell should—

- Summarize observation effort and conditions, the number of animals seen by species, the location and time of each sighting, position relative to the survey vessel, drill vessel and support vessels, the company's activity at the time, each animal's response, and any adjustments made to operating procedures.
- Provide all spatial data electronically and on hard copy charts (always including vessel location).
- Make all data available in the report or (preferably) electronically for integration with data from other companies.
- Estimate and report (1) statistical power for all methods intended to detect adverse impacts and (2) uncertainty in all reported estimates (e.g., number of takes).
- Integrate all observer data with information from tagging and acoustic studies to provide a more comprehensive description of the acoustic environment during its survey.

- Accommodate specific requests for raw data, including tracks of all vessels and aircraft associated with the operation and activity logs documenting when and what types of sounds are introduced into the environment by the operation.

4.3. SHELL DRILLING IN THE CHUKCHI SEA

4.3.1. Each IHA applicant's monitoring program should document the effects (including acoustic) on marine mammals and document or estimate the actual level of take as a result of the activity. Does the monitoring plan meet this goal?

The plan meets this goal in part only. Shell will use vessel-based MMOs and either bottom-founded hydrophones or a system of radio spar buoys to monitor near the drill site. The utility of MMOs depends largely on visibility, and all the standard concerns apply with regard to periods of low visibility (e.g., darkness, rough sea state, inclement weather). The use of the acoustic monitoring will help compensate for poor visibility, but the accuracy of acoustic data for the purpose of localizing animals declines beyond approximately 10 km from the hydrophone array, and passive acoustic methods cannot be used to monitor individuals that do not vocalize. If the drilling and support activities cause disturbance beyond this limit, or if vocalization rates are unknown or variable, then the monitoring plan will not be adequate. As a consequence, the company's ability to estimate take also will be compromised.

The panel discussed the concern of Alaska Natives that the activity may result in a change in offshore-to-onshore movement patterns for beluga whales, thereby altering their availability to subsistence hunters along the coastal region of northwestern Alaska during June, July and August. Some panel members anticipate that drilling will have a limited impact on the coastal distribution of beluga whales unless the whales move through the drilling area before approaching the coast. Shell does not plan to conduct aerial surveys near the drilling platform to provide a real-time basis for assessing such movements or mitigating drilling effects. The company does plan to conduct aerial surveys along the coast to examine the distribution of beluga whales and their availability to subsistence hunters. However, panel members were skeptical that the sawtooth design of the surveys will satisfy that purpose as it will not cover offshore areas where belugas are known to occur and it may not be sufficient to characterize beluga whale distribution in coastal waters. With that concern in mind, panel members suggested that Shell consult with subsistence hunters in that region to determine where and when their survey efforts should be focused.

Finally, panel members did not have sufficient information to determine the potential effects of various discharges (e.g., drilling wastes, warm water) around drilling sites and the potential consequences for bowhead whales and other marine mammals in the area.

4.3.2. Review the monitoring plans to ensure that the monitoring activities and methods described in the plans will enable the applicant to meet these requirements

See the response to question 1 above.

4.3.3. Are the applicant's objectives achievable based on the methods described in the plan?

Page 2 of the application lists the objectives for vessel-based monitoring by MMOs.

Objective 1 – *The basis for real-time mitigation, if necessary*. This objective should be met when visibility is good unless significant behavioral effects occur outside the safety radii. The sound levels from drilling are expected to remain below the thresholds of temporary and permanent hearing impairment, although the drilling should be monitored acoustically to confirm that this is the case. Support vessels also will introduce considerable sound levels into the water, thus expanding the area (footprint) in which impacts could occur. Effects of primary concern will be behavioral (e.g., changes in migratory pattern, disruption of mother-calf pairs). Acoustic monitoring should provide a basis for characterizing the sounds from the drilling and support activities, but will not provide a useful basis for real-time mitigation of behavioral effects because of the time needed for data analysis.

Objective 2 – *Estimate the number of takes*. This objective may or may not be achievable depending on visibility, the spatial distribution and variability of the noise field (footprint) from all activities, and resulting behavioral effects. Shell should be able to monitor some effects within 10 km using vessel-based MMOs and a passive acoustic array. If all effects are limited to that area, then monitoring should be sufficient to provide an estimate of the total number of takes. If visibility is poor or effects occur outside that limit, then the estimate may be biased, depending on whether and how Shell adjusts its analysis to compensate for these shortcomings.

Objectives 3, 4 – *Data on the occurrence, distribution, etc., of marine mammals; information to compare the distances, distributions, behavior, and movements with and without drilling*. Panel members expect that these objectives can be achieved only partially; the results will be limited to what the MMOs can see. Shell will be able to collect some baseline data if vessel-based surveys are conducted before drilling starts and the vessels and their sounds do not impact marine mammals.

Page 8 of the monitoring and mitigation plan lists the objectives for acoustic monitoring.

Objective 1 – *Quantify the absolute sound levels and monitor variation with time, etc.* This objective can be achieved with acoustic monitoring.

Objective 2 – *Measure the sound levels produced by vessels operating in support of the drilling operation*. This objective also can be achieved with acoustic monitoring. The planned acoustic monitoring should provide good information on the sounds at the drill site.

Shell has collected acoustic baseline data in previous years. Presumably, those data will be representative of the year they were collected. With regard to the proposed exploratory drilling, Shell will be able to collect additional baseline data on acoustic conditions only if the company monitors the area for some period prior to the start of drilling operations.

4.3.4. Are the applicant's objectives the most useful for understanding impacts on marine mammals?

Some panel members disagreed with Shell's decision to categorically exclude aerial surveys for monitoring. As described earlier (section 3.2), aerial surveys do entail some degree of risk, but that risk can be managed and minimized. Indeed, the Service, with support from the Minerals Management Service, conducts aerial surveys in the area of concern by careful management of the associated risk.

Acoustic monitoring at this site should provide a rich and useful database, although those data will not compensate fully for the data that could be collected using aerial surveys.

4.3.5. Should the applicant consider additional monitoring methods or modifications of proposed monitoring methods for the proposed activity?

Shell should review the results of vessel-based and acoustic surveys at the Burger site to learn what it can about baseline information on the occurrence of marine mammals.

Some panel members thought that Shell should make better use of support helicopters to collect visual data near the drill site if Shell is not going to fly fixed-wing aerial surveys. Two options would be to (1) conduct aerial surveys near the drill site using the helicopter from the drill ship or a nearby support vessel, and (2) use transits to and from land to the drill site to collect pertinent information on marine mammal occurrence in the area. At a minimum, the helicopter could conduct dedicated short surveys around the drill vessel before returning to shore. The panel would like to see a cost/benefit analysis of this kind of approach. Absent the use of fixed-wing or helicopter surveys, Shell should continue to pursue the use, and investigate the efficacy, of unmanned aircraft technology for monitoring and mitigation purposes near the drill site.

Shell should maintain and make available detailed logs for all aspects of its program, including activities on the drill ship and all support activities. It should integrate this information with data from acoustic and MMO monitoring and environmental studies to provide a comprehensive assessment of potential effects. To that end, Shell should be open to sharing information and coordinating with any other company that decides to work in the same area to provide a basis for comprehensively assessing the cumulative effects of multiple operations.

Shell's objective 1 on page 8 (*quantification and measuring of sound levels*) is not sufficient inasmuch as simply monitoring sound levels does not provide adequate characterization of the soundscape (see section 3.1). In this regard, Shell should collect, retain, and analyze sound and other data for all aspects of its program to allow analysts to create a more comprehensive characterization of the disturbance caused by exploratory drilling and the resulting potential to take marine mammals.

With regard to potential effects on beluga whales, Shell should conduct its nearshore aerial surveys, but should consult with subsistence hunters in the area to focus the survey effort and initiate the surveys by ~20 June to provide baseline information before drilling commences.

4.3.6. What is the best way for an applicant to report their data and results to NMFS?

Shell should—

- Summarize observation effort and conditions, the number of animals seen by species, the location and time of each sighting, position relative to the survey, drilling, and support vessels, the company's activity at the time, each animal's response, and any adjustments made to operating procedures. Provide all spatial data on charts (always including vessel location).

- Make all data available in the report or (preferably) electronically for integration with data from other companies.

- Estimate and report (1) statistical power for all methods intended to detect adverse impacts and (2) uncertainty in all reported estimates (e.g., number of takes).

- Integrate all observer data with information from tagging and acoustic studies to provide a more comprehensive description of the acoustic environment during its survey.

- Accommodate specific requests for raw data, including tracks of all vessels and aircraft associated with the operation and activity logs documenting when and what types of sounds are introduced into the environment by the operation.

4.4. SHELL MARINE SEISMIC IN THE BEAUFORT AND CHUKCHI SEAS

4.4.1. Each IHA applicant's monitoring program should document the effects (including acoustic) on marine mammals and document or estimate the actual level of take as a result of the activity. Does the monitoring plan meet this goal?

The monitoring plan meets the goal for the airgun array, but not for the other sources of sound used during the various operations. Taken together, these activities will create a complex sound field with potential effects beyond those that the applicant proposes to monitor. Although it is reasonable to focus the monitoring program on the most intense sound sources, other noises from these operations may be more significant for certain species because of their differential hearing capabilities and differences in the ambient background noise. With that in mind, each major component of the seismic survey should be measured and evaluated. In addition, the plan does not clarify whether ice seals disturbed by helicopter flights will be included in the take estimates. Similarly, the acoustic "footprint" of the autonomous underwater vehicle was not described and may not be known.

Aerial surveys combined with the acoustic monitoring plan will be helpful to understand the effects of shallow hazard surveys in the Beaufort.

4.4.2. Review the monitoring plans to ensure that the monitoring activities and methods described in the plans will enable the applicant to meet these requirements

See response to question 1.

4.4.3. Are the applicant's objectives achievable based on the methods described in the plan?

Vessel-based survey objectives (page 2) can be partially achieved with the monitoring plan.

Objective 1 – *Basis for real-time mitigation*. Real-time mitigation may or may not be achieved, depending on where takes occur. If they occur beyond the line of sight or when visibility is poor, then the objectives will not be met. Even with good visibility the objectives might not be met if MMOs fail to detect marine mammals in safety zones. The likelihood of detection for animals in these zones is less than one and has not been quantified, but should be to determine the efficacy of visual observations.

Objective 2 – *Information needed to estimate the levels of takes*. This objective cannot be achieved because the focus of the plan is entirely on the airguns and does not include sources of higher frequency sounds that may take marine mammals.

Objectives 3 and 4 – *Data on the occurrence, distribution, and activities of marine mammals; information to compare the distances, distributions, behavior and movements with and without airgun activity*. These objectives

can be achieved only partially because of the known limitations of vessel-based visual observations (section 3.3). Comparisons of marine mammal distances, distributions, behaviors and movements cannot be determined reliably during periodic breaks in airgun activity (section 3.6). Instead, such an investigation requires dedicated surveys during periods of sufficient duration to ensure that the animals have resumed normal movements, distribution, and behavior. That is, baseline information is almost certainly too complex to assess during periodic breaks in seismic surveys.

Aerial survey objectives (page 10) also can be partially achieved.

Objective 1 – *Advise operating vessels as to the presence of marine mammals in the vicinity*. Shell should be able to achieve this objective. However, panel members had some concern that the survey area was too large and that the aerial surveys would be more effective if they were more focused around the seismic vessel where effects are most likely to occur. In this regard, aerial surveys complement vessel-based MMO surveys if they help cover the visual far-field. At the same time, over-extending the visual far-field (i.e., to an area too large) would compromise the utility of aerial surveys for mitigation purposes. Also, as noted in section 3.2, panel members do not believe that aerial surveys can be used simultaneously for mitigation and monitoring purposes without suitable adjustments in analytical methods.

The objective of the acoustic study of bowhead deflection (page 19) can be achieved using passive acoustic arrays, has provided important information in the past, and should be continued in the future to shed more light on the effects of sound from oil and gas activities on bowhead whales.

4.4.4. Are the applicant's objectives the most useful for understanding impacts on marine mammals?

No, the applicant's objectives are not the most useful for understanding impacts on marine mammals. The acoustics objectives are vague and do not include a metric by which success can be measured. They should be revised to be more specific. For example, a more useful objective would be "to estimate the probability of whale deflection as a consequence of the suite of operations occurring in this area."

The objectives for the acoustic component also are focused on bowhead whales to the exclusion of other marine mammals. Pinnipeds and other species of cetaceans should be addressed as well.

Some panel members believe that aerial surveys would be helpful for understanding the distributions of marine mammals in this area during July and August.

4.4.5. Should the applicant consider additional monitoring methods or modifications of proposed monitoring methods for the proposed activity?

Shell may use a number of technologies that produce high-frequency sounds. Therefore, the company also should assess the effects of those sounds and establish mitigation measures such as safety radii for marine mammals, where appropriate. Directional autonomous seafloor acoustic recorders used in the Beaufort Sea will not provide information on the high frequency sounds and cannot be used to monitor and evaluate marine mammal responses to those high-frequency sounds.

As members of the panel have emphasized with all applicants, it will be critical that Shell integrate the information gained from its acoustic methods, vessel-based MMOs, dedicated vessel-based marine mammal surveys, aerial surveys, and environmental studies to provide a more comprehensive

ecosystem-based assessment of the effects of oil and gas operations. To that end, Shell should work with other companies to devise methods for integrating all its data into such an assessment. Doing so will require keeping detailed logs of all activities, whether related to seismic surveys, drilling, or support functions. This information also should be combined with pertinent biological (e.g., tagging) and environmental (e.g., ice) data to provide a more comprehensive means for assessing the ecosystem and potential effects from oil and gas activities.

4.4.6. What is the best way for an applicant to report their data and results to NMFS?

Shell should—

- Summarize observation effort and conditions, the number of animals seen by species, the location and time of each sighting, position relative to the survey vessel, the company's activity at the time, each animal's response, and any adjustments made to operating procedures. Provide all spatial data on charts (always including vessel location).

- Make all data available in the report or (preferably) electronically for integration with data from other companies.

- Estimate and report (1) statistical power for all methods intended to detect adverse impacts and (2) uncertainty in all reported estimates (e.g., number of takes).

- Integrate all observer data with information from tagging and acoustic studies to provide a more comprehensive description of the acoustic environment during its survey.

- Accommodate specific requests for raw data, including tracks of all vessels and aircraft associated with the operation and activity logs documenting when and what types of sounds are introduced into the environment by the operation.

4.5. TGS SEISMIC SURVEY

The panel considered the application from TGS to constitute only a preliminary outline of the information needed to apply for authorization to conduct the proposed activity. The monitoring plan, in particular, would require substantial augmentation before the panel could conduct a meaningful review. For example, the monitoring plan included only MMOs, which the panel members do not consider sufficient for estimating take and determining overall effects, especially for a seismic survey with a relatively large airgun array. At a minimum, a revised monitoring plan for a seismic survey of this size should incorporate MMOs as well as additional acoustic monitoring methods, including those for estimating effects/takes in the far field. Such methods might include acoustic monitoring and/or aerial surveys. Ideally, the monitoring plan also would describe coordination with other operators in the area, including how numerous data sets from multiple sources would be integrated into the analysis of effects.

4.6. STATOIL SEISMIC

4.6.1. Each IHA applicant's monitoring program should document the effects (including acoustic) on marine mammals and document or estimate the actual level of take as a result of the activity. Does the monitoring plan meet this goal?

The goal will be met only partially. The monitoring plan calls for vessel-based MMOs and would collect acoustic information, but methods for estimating takes in the visual far-field are minimal to nonexistent.

In addition, Statoil may have difficulty estimating takes in the visual near-field, particularly if safety radii extend far from the vessel and beyond the line of sight. Panel members expressed concern that the proposed methods would not be sufficient for adequate monitoring of the area within the safety radii when the radii are far from the vessel. Members also questioned whether MMOs would be able to see further than the safety radii to collect sightings data used to estimate animal density and total takes. Without such information, the estimated number of takes will be biased low.

4.6.2. Review the monitoring plans to ensure that the monitoring activities and methods described in the plans will enable the applicant to meet these requirements

See the response to question 1.

4.6.3. Are the applicant's objectives achievable based on the methods described in the plan?

Statoil's objectives for its vessel-based observations are listed on page 57 of its application.

Objective 1 – *Use observations to determine when to implement mitigation measures during the seismic operation*. This objective cannot be achieved fully because the observers likely would not be able to monitor all the areas within the safety radii. In practice, the MMOs likely would be able to monitor only a small portion of those areas during the limited portion of the survey when visibility is good to excellent.

Objective 2 – *Obtain information needed to estimate the number of marine mammals potentially exposed to 160dB*. This objective can be achieved only in part. Although the MMOs on the chase vessels will help provide information on take levels w/in 160 dB, they, too, will be able to monitor only a limited area. Panel members would need to know specific plans for the operation of the chase vessels to judge how well MMOs on those vessels would be able to sample the areas within the 160 dB radii. That information was not included in the application. In addition, the panel noted that much of this survey would occur at night, when vessel-based visual monitoring cannot be used to satisfy this objective. It also is not clear how Statoil would monitor beyond the 160 dB radii, where previous seismic surveys have affected bowhead whales.

Objective 3 – *Compare distance/distribution of marine mammals relative to the source vessel at times with and without seismic activity*. This objective can be met partially, at best. Here, too, MMO limitations preclude monitoring of the entire area of concern, so comparisons will be limited. In addition, the duration of periods with no seismic testing was not clear, and the panel was not convinced that sampling during those periods will provide a reliable basis for characterizing baseline behavior.

Statoil's acoustic objectives are listed on page 58 of its application.

Based on discussion with Statoil representatives, the monitoring plan in their application no longer reflects their current plan for acoustic monitoring. They indicated that they will participate in the installation of a single acoustic array, but the panel understood that the array will monitor only a

portion of the survey area. Other portions of their survey area will not be assessed using acoustic recorders. Without more information regarding implementation of the array, panel members found the company's proposed acoustic plan to be incomplete. At the least, the array should be designed to characterize the full extent of the seismic survey area. Ideally, it also would be useful for monitoring any other relevant biological and/or acoustic features of the area.

4.6.4. Are the applicant's objectives the most useful for understanding impacts on marine mammals?

Objectives for acoustics were provided, but the information on the acoustic monitoring plan was not sufficient to judge whether the objectives are the most useful.

4.6.5. Should the applicant consider additional monitoring methods or modifications of proposed monitoring methods for the proposed activity?

Statoil has indicated that it will not use aerial surveys, claiming that they are "impractical and unsafe." As described above (section 3.3), some members of the panel disagree with this assessment. At the least, aerial surveys could be conducted in a portion of the proposed survey area.

Absent the use of aerial surveys, the application falls short with regard to visual far-field monitoring. The applicant's only option is to find alternative methods for collecting the essential information. At present, the only alternative available to the company is to use a combination of passive acoustic monitoring, dedicated vessel-based marine mammal surveys, and vessel-based MMOs. All this information will need to be integrated with pertinent environmental data to provide a reasonably accurate assessment of potential effects.

Statoil could strengthen its monitoring and analyses by coordinating with other operations in the area to share data (including tagging data) and thereby provide a more robust assessment of baseline information and potential effects of seismic surveys. Consistent with this, Statoil should keep careful logs of vessel positions, tracks, and activities.

Statoil offered to conduct a cumulative effects analysis of the sounds in the Chukchi Sea, but did not explain how this would be accomplished. This would be very helpful, but the value of such an analysis will depend heavily on the extent to which pertinent data are collected by the various companies and shared for the purpose of conducting a comprehensive analysis.

4.6.6. What is the best way for an applicant to report their data and results to NMFS?

Statoil should—

- Summarize observation effort and conditions, the number of animals seen by species, the location and time of each sighting, position relative to the survey vessel, the company's activity at the time, each animal's response, and any adjustments made to operating procedures. Provide all spatial data on charts (always including vessel location).

- Make all data available in the report or (preferably) electronically for integration with data from other companies.

- Estimate and report (1) statistical power for all methods intended to detect adverse impacts and (2) uncertainty in all reported estimates (e.g., number of takes).

- Integrate all observer data with information from tagging and acoustic studies to provide a more comprehensive description of the acoustic environment during its survey.

- Accommodate specific requests for raw data, including tracks of all vessels and aircraft associated with the operation and activity logs documenting when and what types of sounds are introduced into the environment by the operation.

5. ACKNOWLEDGMENTS

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7. PANEL MEMBERS

The members of the review panel were—

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