

Expert Panel Review of Monitoring Protocols in Applications for Incidental Harassment Authorizations Related to Oil and Gas Exploration in the Chukchi and Beaufort Seas, 2011: Statoil and ION Geophysical

**Anchorage, Alaska
9 March 2011**

1. BACKGROUND

Sections 101(a)(5)(A) and (D) of the Marine Mammal Protection Act (MMPA) allow for the incidental, but not intentional, taking of small numbers of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographic region. For activities that occur in Arctic waters and have the potential to affect the availability of a species or stock of marine mammal for subsistence uses, the monitoring plan for the proposed activity must be independently peer-reviewed. To aid the National Marine Fisheries Service (NMFS) in its review of the monitoring plans for the upcoming season, NMFS holds an annual Open Water Meeting in Anchorage, Alaska, each spring. The meetings are open to the public and provide an opportunity for applicants to share the results of monitoring programs from the previous year and present the monitoring plans for activities proposed for the upcoming open water season. The meeting also allows for input and comments from Alaska Natives, industry representatives and industry-funded scientists, government representatives, environmental organizations, and interested members of the public on the results of the previous year's monitoring programs and the proposed monitoring plans for the upcoming season.

In 2011, NMFS, working with the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE), sponsored the Open Water Meeting on 7-8 March. At the time of the meeting, NMFS had received two applications for Incidental Harassment Authorizations (IHAs), one from Statoil and the other from ION Geophysical, to take marine mammals by harassment incidental to industry operations. For each of these applications, NMFS 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. NMFS also must prescribe (1) regulations establishing permissible means of taking and other means of effecting the least practicable adverse impact, and (2) monitoring and reporting requirements.

The methods most often described in monitoring plans have two specific goals. 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 relatively small “safety” zone intended to minimize the probability of injury). The second objective is to provide sufficient information about distribution and movement of animals to support a sufficiently robust post-hoc analysis of the number of animals that may have been taken incidental to, and the potential effects of, industry activities. Thus, the former type of monitoring is used to provide a degree of protection for animals from harm during operations, whereas the latter is used to estimate post-hoc just what the impact was based on number and types of takes.

According to NMFS policy guidelines, the marine mammal monitoring prescribed in the terms of either an IHA or Letter of Authorization (LOA) and generally required of action-propONENTS (e.g., oil and gas industry, military) whose operations may impact marine mammals and other protected species should be designed to accomplish or contribute to one or more of the following:

- a) An increase in our understanding of the likely occurrence of marine mammal species in the vicinity of the action, i.e., presence, abundance, distribution, and/or density of species.
- b) An increase in our understanding of the nature, scope, or context of the likely exposure of marine mammal species to any of the potential stressor(s) associated with the action (e.g.,

- sound), through better understanding of one or more of the following: 1) the action itself and its environment (e.g., sound source characterization, propagation, and ambient noise levels); 2) the affected species (e.g., life history or dive patterns); 3) the likely co-occurrence of marine mammal species with the action (in whole or part) associated with specific adverse effects, and/or; 4) the likely biological or behavioral context of exposure to the stressor for the marine mammal (e.g., age class of exposed animals or known pupping, calving or feeding areas).
- c) An increase in our understanding of how individual marine mammals respond (behaviorally or physiologically) to the specific stressors associated with the action (in specific contexts, where possible, e.g., at what distance or received level).
 - d) An increase in our understanding of how anticipated individual responses, to individual stressors or anticipated combinations of stressors, may impact either: 1) the long-term fitness and survival of an individual; or 2) the population, species, or stock (e.g., through effects on annual rates of recruitment or survival).
 - e) An increase in our understanding of the effectiveness of mitigation and monitoring measures.
 - f) A better understanding and record of the manner in which the authorized entity complies with the incidental take authorization.

2. PEER-REVIEW PANEL OBJECTIVES

To satisfy the peer-review requirements of section 216.108(d) of the regulations pertaining to issuance of IHAs in areas of the Alaskan Arctic, NMFS convened an expert peer-review panel (hereafter the “panel”) of five scientists and one experienced Inupiat hunter, with diverse backgrounds and familiarity with marine mammal natural history and biology, research, and conservation in the Arctic regions of Alaska. A facilitator with extensive background in Arctic marine mammal science, conservation, and management issues assisted with the discussions among the panelists and between the panel and industry representatives. This was the second such panel conducted in conjunction with the Arctic Open Water Meetings to consider the previous and proposed monitoring plans; four members of the panel and the facilitator from 2010 also participated in 2011. On March 9, 2011, panel members reviewed the two IHA applications from Statoil and ION Geophysical and discussed specific recommendations (meeting minutes available upon request). The panel considered how components of monitoring plans applied to all lines of investigation identified in NMFS’ policy guidelines stated above, although expert panelists were instructed to focus primarily on deriving a robust estimate of actual takes and enhancing understanding of the potential effects of industry’s activities on marine mammals. Panel members did not strive for consensus on specific points; differing perspectives are indicated herein by reference to “some” and “others.”

The specific guidance given to the panel was as follows:

Each IHA applicant’s monitoring program should be designed to accomplish one or more of the following: document the effects of the activity (including acoustic) on marine mammals; document or estimate the actual level of take as a result of the activity (in this case, seismic or marine surveys or icebreaking); increase the knowledge of the affected species; or increase knowledge of the anticipated impacts on marine mammal populations. OPR [NMFS’ 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 stated goals.

Specifically, OPR would like the panel to discuss the following questions with regards to each monitoring plan:

- Are the applicant's stated objectives the most useful for understanding impacts on marine mammals and otherwise accomplishing the goals stated in the paragraph above?
- Are the applicant's stated objectives able to be achieved based on the methods described in the plan?
- Are there techniques not proposed by the applicant, or modifications to the techniques proposed by the applicant, that should be considered for inclusion in the applicant's monitoring program to better accomplish the goals stated above?
- 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?

This report documents the panel's evaluation of Statoil's and ION's proposed monitoring plans for 2011 and provides recommendations for improvements that could be enacted for operations conducted within two timeframes: a) 2011; or b) in the near future, possibly with intermediate steps before complete compliance. Specific *recommendations* are numbered consecutively throughout this report.

3. RESULTS OF 2010 PEER-REVIEW PANEL RECOMMENDATIONS

The panel requested a report from staff of NMFS' Office of Protected Resources on the implementation of the recommendations from the 2010 panel. OPR reported that while the primary purpose of the review was to provide an assessment of the monitoring plans for NMFS, the 2010 panel report is publically available on the OPR website. The recommendations from the 2010 panel were discussed within OPR and the NMFS Alaska Regional Office. Additionally, OPR sent letters requesting that Statoil and Shell make specific changes to their respective monitoring plans as a result of comments by the panel. The letters from OPR included requirements for both 1) specific panel recommendations NMFS expected the companies to implement in the 2010 monitoring plans for their IHAs and 2) improvements to monitoring plans they should consider implementing in 2011 and beyond. OPR staff held conference calls with company representatives to make sure they understood the new recommendations and requirements.

OPR's letters to each company added specific requirements to the 2010 IHAs, in part resulting from panel recommendations, including additional observer training requirements, the use of high-power "big eye" binoculars, conducting observations from the highest possible position on the boat, and prioritizing observation of safety radii over acquiring detailed behavior data, among others. OPR additionally required that companies share raw data from their monitoring plans upon request. OPR also requested that the companies collect additional information pertaining to the effectiveness of the "ramp-up" mitigation procedure for airgun operations that is a current industry standard despite a lack of study as to its actual efficacy.

The panel noted and appreciated industry's efforts to pursue new monitoring technologies during operations in 2010. Specifically, ION pursued the panel's recommendation to investigate the use of thermal imaging technology for night observations but did not implement its use because their 2010 seismic program was postponed. Additionally, Statoil investigated the use of a towed passive acoustic monitoring array. Results of this feasibility test were presented and discussed at the 2011 Open Water Meeting. Statoil's tests enabled evaluations of the pros and cons of this new equipment application and provided a better understanding of whether and how this technology might substantially improve an integrated approach to marine mammal monitoring during the open water period.

The panel discussed the requisite follow-up to ensure the companies implemented the new requirements in their monitoring plans that resulted from the 2010 panel recommendations. Members of the panel expressed some concern about the lack of willingness of some companies to provide certain non-proprietary data (aerial and vessel-based marine mammal survey data; acoustic detections of marine

mammals and any marine mammal responses to sound; biological and physical oceanographic data; location and movement of equipment operating in the region; type of equipment used, including characteristics of sound intensity and frequency, sound propagation in the environment at the time of the activity, and duty cycles; and timing of the activity) upon request. OPR committed to review the 90-day reports to ensure that the new requirements (e.g., incorporating uncertainty into post-season estimates of take) had been addressed.

Building on the successes of the framework established in 2010, the panel recommended that the following actions be taken to assist NMFS in interpreting future panel recommendations and to ensure that the companies implement the prescribed recommendations:

Recommendations

- (1) Companies should be asked specifically to report what changes they made in their operations as a result of the previous years' panel recommendations. These should be highlighted in their verbal presentations at the Open Water Meeting, discussed directly with the review panel, and detailed in their 90-day reports (and final reports, if appropriate).
- (2) NMFS should follow up with the panel shortly after the draft panel report is submitted to NMFS to make sure NMFS understands the recommendations so that they can better communicate the recommendations to industry.
- (3) NMFS should follow up with industry to ensure that the new IHA requirements resulting from NMFS' decisions based on the panel's recommendations were implemented, both in the field and in the reports.

4. GENERAL RECOMMENDATIONS AND COMMENTS

Some of the 2010 panel recommendations were more overarching and/or long-term than a single company's monitoring plan or activities. These recommendations encouraged NMFS and all stakeholders to take a more comprehensive view of increasing development in the Arctic, in addition to the narrow, single operation approach that historically has been applied. Panel members encouraged the agency to incorporate some of these more programmatic recommendations regarding consideration of the concept of acoustic "habitat" and aggregate/cumulative effects of multiple types of human activities within new NEPA compliance assessments being developed for Arctic exploration and production activities (see recommendation 12.ii of this report). Within this process, NMFS should recognize the critical importance of the acoustic habitat for basic life functions in marine mammals and other marine life and establish management processes to protect not only individual animals but the overall acoustic habitat.

Over the course of the panel review, the panel frequently touched on general recommendations and comments that had previously been raised in the 2010 panel review. Section 3.0 from the 2010 meeting is incorporated here by reference (see Appendix A for a summary of the recommendations from the 2010 panel), with updates as discussed below.

4.1 ACOUSTIC EFFECTS OF OIL AND GAS EXPLORATION – ASSESSMENT AND MITIGATION

As identified in the 2010 panel report, the potential environmental impacts of noises produced by exploration and production activities include both small-scale, short-term effects (i.e., acute), and large-scale, long-term influences (i.e., chronic). Acute effects from single noise sources (e.g., seismic airgun array, pile driving) are presently assessed by acoustic monitoring and post-processing these data to estimate sound exposure levels at nearby animals. Acute cumulative effects on animals as a result of multiple noise sources from simultaneous activities are not considered, and neither are the potential chronic influences from multiple noise sources. For large whales and some pinnipeds, such as the

bowhead whale, bearded seal, and walrus, which produce low-frequency sounds (< 1000Hz) for communication, masking of communication sounds as a result of cumulative noises can result in the loss of communication opportunities (Clark et al. 2009). There is growing evidence that under chronic noise conditions the impacts of acoustic masking could have biological consequences. Furthermore, as noted by the 2010 panel, sufficient evidence exists to conclude that factors of sound exposure other than simply the received level are key determinants of potential impact, particularly regarding behavioral response probability. The current panel reiterates these broader recommendations for NMFS to consider and integrate into decision-making in conservation management on a more programmatic basis. This concern is especially pertinent because migrating bowhead whales are highly sensitive to low levels of anthropogenic sounds (IWC 2007, pg. 233). Additionally, and in some cases related to these overarching conclusions, members of the panel made recommendations resulting from specific observations regarding acoustic effects.

First, all acoustic sources of operations should be included both from a mitigation and a monitoring perspective. As mentioned above, most of these assessments are focused on acute, high-power sources such as seismic airgun arrays. While these are clearly important, often lost in these assessments are sounds that may have lower total instantaneous power output, but may operate more continuously or over broader areas (e.g., service or supply vessels), or may occur at somewhat higher frequencies but still within audible range of most species and at relatively high output power (e.g., some sub-bottom profilers used in shallow hazard surveys). These assessments should consider the differential hearing abilities of differing marine mammal species (see Southall et al., 2007), and the physics governing underwater sound production and propagation. Furthermore, under present acoustic impact guidelines, seismic airgun signals are categorized as impulses, even for ranges at which a significant portion of the original acoustic impulse energy is converted into broadband reverberation and/or frequency dispersive components with biologically salient features. Thus, seismic airgun signals should not be treated as truly impulsive when received at ranges where sound propagation is known to remove the impulsive nature of these signals. Over very short ranges where potential hearing loss (temporary or permanent) can occur, airgun impulses retain their impulsive features and should be considered as impulses. As distance from the seismic source increases, and the area over which behavioral impacts could occur increases, the impulsiveness of the signal is no longer its dominant acoustic feature and the signal should no longer be considered or regulated as an impulse.

Second, NMFS should provide companies with explicit information about what acoustic aspects of their activities need to be detailed in their IHAs and incorporated into take estimates. For example, this could be accomplished by recommending certain combinations of frequencies, propagating signal types and source levels that should be thoroughly addressed in the IHAs, and some measures of the spatial and temporal scales over which the activities extend.

Third, the probability of behavioral impact from specific activities should be assessed based on the best available science that is most appropriate and similar to the condition of exposure that will occur. The panel specifically noted large differences in the existing literature about the response probability for migrating bowhead whales relative to feeding/socializing individuals (see Southall et al., 2007, for a discussion). Migrating bowhead whales respond to anthropogenic sounds at much greater distances and at much lower received levels than feeding bowhead whales. Thus the behavioral context appears in this case to be a key driver of response probability, rather than merely the loudness of the received sound, which is the common metric by which these impacts have previously been regulated. Consequently, the behavioral state of animals must be considered in assessing potential impacts on animals at different times of the year or in different habitats; this might require modification to existing marine mammal observer protocols so that the ability to detect marine mammals is not compromised by the need to determine the animals' behavioral state. Where significant uncertainty exists, such as when it is difficult to ascertain the whale's behavior, a precautionary means of predicting response should be applied.

Recommendations

- (4) All significant acoustic sources of operations should be included both from a mitigation and a monitoring perspective.
- (5) Assessments of sound sources should consider the differential hearing abilities of differing marine mammal species (see Southall et al., 2007) and the physics governing underwater sound production.
- (6) NMFS should provide companies with explicit information about what acoustic aspects of their activities need to be detailed in their IHA applications and incorporated into take estimates.
- (7) The probability of behavioral impact from specific activities should be assessed based on the best available science that is most appropriate and similar to the condition of exposure that will occur. Where significant uncertainty exists, such as when it is difficult to ascertain the whale's behavior, a precautionary means (i.e., the behavioral state when whales are most sensitive to anthropogenic sounds) of predicting response should be applied.
- (8) NMFS should routinely require that the authorized entity report estimates of the spatio-temporal distributions of acoustic levels. Some panel members recommended that this reporting explicitly include acoustic levels at least as low as the 120 dB level because evidence exists to suggest that this received level has caused bowhead whales to deflect, or be entirely excluded from, an area (Brewer et al., 1993; LGL Ltd. and Greeneridge Sciences Inc., 1987; Davies, 1997; and Hall et al., 1994). Others thought that the 120 dB level should not be explicitly referenced due to the inherent complexity of the system, as marine mammal reactions to noise are likely a function of multiple factors.

4.2 AERIAL SURVEYS

Panel members spent minimal time discussing aerial surveys because neither proposed 2011 monitoring plan incorporated aerial surveys. Aerial surveys remain a useful tool for conducting far-field monitoring in some conditions, and the points made in the previous report remain relevant. Section 3.2 from the previous report is incorporated by reference (see Appendix A for a summary of recommendations from the 2010 panel).

4.3 MARINE MAMMAL OBSERVERS

Panel members specifically highlighted a few of the issues regarding marine mammal observers identified in 2010 (summarized in Appendix A), namely, the importance of having observers that are independent from industry, and the need for a tool to assess the observers' abilities to identify species. There is also a need for an independent debrief of observers to identify problems from the previous monitoring efforts and to recommend improvements for future efforts.

Significant concerns remain that the observers for the oil and gas industry are not independent of the industry, because the observers are contracted, trained, deployed, and debriefed by individuals working directly for the industry, and the observer data is transmitted, quality controlled, analyzed, released, and archived by the industry. This model was rejected long ago for the commercial fishing industry: at a minimum, when an observer program is required for a commercial fishery, the federal government trains and debriefs the observers, and conducts the quality control, analysis, release, and archival of the data.

The panel also identified that no assessment tool exists to determine whether marine mammal observers (MMOs) are correctly identifying sightings to species. It is not clear whether observers are required to demonstrate their ability to identify Arctic marine mammals before they begin observing. At the least,

observers should pass an identification test, using material that is different than what was used during training, before beginning stints as Arctic MMOs.

The 2010 panel recommended that MMOs should provide more details about observed characteristics of marine mammals that were not identified to species. For example, if an unknown mysticete was seen, it should be noted whether it had a dorsal fin. If only a blow was observed, it should be recorded as only a blow. MMOs may have recorded those details, as required in the 2010 IHAs, but those details are not included in the 90-day reports. They should be included in the final reports.

Recommendations

- (9) NMFS should investigate funding and implementing an independent observer program to replace the current system of vessel-based marine mammal observers for the oil and gas industry.
- (10) NMFS should require that MMOs pass an Arctic marine mammal identification test, with material that is different than what was used in training, before serving on an industry vessel.
- (11) NMFS should require that MMOs record additional details about unidentified marine mammal sightings, such as “blow only”, mysticete with (or without) a dorsal fin, “seal splash”, etc. That information should also be included in 90-day and final reports.

4.4 VISUAL NEAR-FIELD MONITORING

Section 3.4 from the previous report is incorporated by reference (see Appendix A for a summary of the recommendations from the 2010 panel).

4.5 VISUAL FAR-FIELD MONITORING

Section 3.5 from the previous report is incorporated by reference (see Appendix A for a summary of the recommendations from the 2010 panel).

4.6 BASELINE BIOLOGICAL AND ENVIRONMENTAL INFORMATION

Section 3.6 from the previous report is incorporated by reference (see Appendix A for a summary of the recommendations from the 2010 panel).

4.7 COMPREHENSIVE ECOSYSTEM ASSESSMENTS AND CUMULATIVE IMPACTS

The 2010 panel report included a section regarding the need for a more robust and comprehensive means of assessing the collective or cumulative impact of many of the varied human activities that contribute noise into the Arctic environment (see Section 4.1 above). The essence of those observations was that for many species, sounds generated by human activities overlap those used by the marine mammals, and the potential impacts from these human activities should be determined not by each activity in isolation, but rather by the cumulative effects from the suite of human activities in relation to the biological and environmental events. The 2010 panel suggested, and the 2011 panel reiterates that, in addition to the mitigation and monitoring of single activities, as occurs with IHA or LOA applications, NMFS should develop an overarching means of assessing and requiring steps to minimize the collective impacts of development activities on marine ecosystems, including marine acoustic habitats. This will require a fundamentally different mode of assessment than has previously been applied under federal law; the panel encourages NMFS to strongly consider how this may be accomplished within the ongoing programmatic EIS for Arctic oil and gas exploration and production. Cumulative impacts could and should be assessed in IHAs using risk assessment methodology.

In addition to the overarching recommendation for a more holistic and biologically relevant means of assessing the overall footprint (acoustic and otherwise) of human development in the Arctic, the 2010 panel made a number of specific recommendations about comprehensive ecosystem assessment and cumulative impacts (Appendix A). These are presented in similar form here, with some modifications derived in the 2011 panel review process.

Recommendations

- (12) NMFS should develop a framework for assessing, and requiring steps to minimize, the collective impacts of human activities on marine ecosystems, including acoustic habitats. This can be addressed two ways:
- i. NMFS should require in IHAs that cumulative impacts assessments be conducted.
 - ii. In the pending Arctic EIS for oil and gas exploration, NMFS should address the issues and incorporate the recommendations identified in the 2010 and 2011 panel reports. The following ongoing issues are particularly important:
 - a. Evaluating monitoring techniques and the limitations thereof;
 - b. Requiring improvements in both near-field and far-field monitoring techniques;
 - c. Improving techniques for estimating the number of takes when companies or organizations request an IHA or LOA, and improving methods for estimating the number of marine mammals actually taken (or exposed) during operations;
 - d. Assessing cumulative impacts and proposing thresholds for limiting the total amount of human activity in the Alaskan Arctic to protect marine mammals, their habitat, and the availability of marine mammals to subsistence hunters.
- (13) Data analysis and integration:
- i. To better assess impacts to marine mammals, data analysis should be separated into periods when a seismic airgun array (or a single mitigation airgun) is operating and when it is not. Final and comprehensive reports to NMFS should summarize and plot:
 - a. Data for periods when a seismic array is active and when it is not;
 - b. The respective predicted received sound conditions over fairly large areas (tens of km) around operations.
 - ii. To allow visualization and interpretation of the complex field of anthropogenic activities and distributions and movements of marine mammals, the final and comprehensive reports required by the IHA should provide all spatial data on figures that depict the locations of the principal sound sources. This could be represented by a diagram in which all MMO sightings (vessel-based and aerial) and acoustic detections are plotted relative to their distance and bearing from a specific sound source. Alternatively, it could be depicted in a map of the region, showing the operation area, tracklines of vessels and aircraft (if applicable), MMO sightings (vessel-based and aerial), and acoustic detections. To facilitate understanding of both the spatial and temporal aspects of the activity and marine mammal responses, these figures would ideally be animated, showing industry activities and sightings or acoustic detections changing through time. Whenever ancillary biological data (e.g., tagging, acoustic, broad-scale aerial survey) are available that are coincident in space and time with the activity, they should be included in these figures.
 - iii. Advances in integrating data from multiple platforms through the use of standardized data formats are needed to increase the statistical power to assess potential effects.

- Therefore, industry should examine this issue and jointly propose one or several data integration methods to NMFS at the Open Water Meeting in 2012.
- iv. To help evaluate the effectiveness of MMOs, reports should include sightability curves (detection functions) for distance-based analyses.
 - v. To better understand the potential effects of oil and gas activities on marine mammals and to facilitate integration among companies and other researchers, the following information should be obtained and provided electronically: the location and time of each aerial or vessel-based sighting or acoustic detection; position of the sighting or acoustic detection relative to ongoing operations (i.e., distance from sightings to seismic operation, drilling ship, support ship, etc.), if known; the nature of activities at the time (e.g., seismic on/off); any identifiable marine mammal behavioral response (sighting data should be collected in a manner that will not detract from the MMO's ability to detect marine mammals); and any adjustments made to operating procedures. These data should be presented in final and comprehensive reports, if practicable.
 - vi. Prior to the 2012 Open Water Meeting companies should discuss the most practical and constructive means of making their marine mammal and environmental data (e.g., aerial and vessel-based marine mammal survey data, acoustic detections of marine mammals and any responses to sound, biological and physical oceanographic data) and other information about their activities (location and movement of equipment operating in the region; type of equipment used, including characteristics of sound intensity and frequency, sound propagation in the environment at the time of the activity, and duty cycles; and timing of the activity) available to the public.
 - vii. During the 2012 Open Water Meeting, companies should propose an approach, method, or organization (e.g., AOOS, NSSI, NSB, NMFS, etc.) that could help accomplish this data-sharing task.

4.8 DUPLICATION OF SEISMIC SURVEY EFFORT

Section 3.8 from the previous report is incorporated by reference (see Appendix A for a summary of the recommendations from the 2010 panel).

4.9 IMPROVING TAKE ESTIMATES AND STATISTICAL INFERENCE INTO EFFECTS OF THE ACTIVITY

Estimating the number of individuals of each species that could potentially be taken incidental to an activity is critically important for NMFS to consider in their determination of whether the activity is likely to have no more than a negligible impact on those species. In addition, estimating the number of individuals of each species that actually were taken incidental to a permitted activity is critically important for NMFS to consider when evaluating whether the monitoring and mitigation measures were effective. However, panel members continue to have concerns that take estimates are not inferred using the best available data; neglect to incorporate existing knowledge on the animal movement (i.e., migration or other movements), which, therefore, tends to negatively bias take estimates; do not incorporate all potential disturbances associated with an activity; and fail to incorporate reliable estimates of uncertainty. Estimates of uncertainty in take estimates are particularly important, because the use of point estimates alone implies a level of certainty that does not exist.

In addition, hypothesis tests conducted on data acquired during operations, which are used to identify whether an activity affected marine mammals, usually are not presented with relevant information on the

power of the tests. The ability to evaluate the reliability of a hypothesis test is low without an estimate of the associated power.

Recommendations

- (14) Reported results from all hypothesis tests should include estimates of the associated statistical power.
- (15) NMFS should continue to assess and apply the evolving best available science in estimating the potential effects of acoustic exposure on marine mammals and other protected species. NMFS and others should expect that this would result in evolving regulatory criteria as our understanding of the underlying complex issues evolves.
- (16) In the meantime, companies should:
 - i. Provide in their reports a clear and complete explanation of methods used to estimate takes. The methods should be transparent and repeatable, and should include all necessary information on species or stock, time period, spatial extent, and other relevant parameters (e.g., whether the data were collected during times when a seismic array was active), including relevant contextual factors such as multiple simultaneous activities.
 - ii. Estimate and report uncertainty in all take estimates. Uncertainty could be expressed by the presentation of confidence limits, a minimum-maximum, posterior probability distribution, etc.; the exact approach would be selected based on the sampling method and data available.
 - iii. Include all potential sources of disturbance (e.g., seismic arrays, sub-bottom profilers, all ships, etc.) in take estimates.
 - iv. Use the best available information to compute estimated takes.
 - a. If multiple sources of reputable information are available, it is generally better to use the more recent information, even if it is not from a peer-reviewed publication, as long as standard scientific practices of data quality control and analysis are followed.
 - b. If multiple sources of concurrent, relevant information result in considerably different take estimates, both sources should be cited and both take estimates should be presented.
 - c. Differences in the species/stock, time period, spatial extent, and other relevant parameters should be investigated to determine how they might bias the take estimates for a specific activity.

4.10 IMPROVING THE PEER-REVIEW PROCESS

There were various suggestions for improving the peer-review process. When monitoring plans were first peer-reviewed in the late 1990s, the process involved more of a dialog about how to modify monitoring plans to meet specific needs identified by researchers or the subsistence community. This approach allowed the industry to participate directly in recommending novel methods for meeting scientific goals that, in some cases, proved very successful. Some members of the panel thought it would be helpful to extend the peer-review panel process to allow more time for an interactive discussion of the objectives, methodologies, technologies, and practical limitations inherent in monitoring plans with the company representatives and consultants.

The panel also asked each company's representatives if they had recommendations for improving the meeting. Statoil suggested delaying the panel meeting by one day to provide the companies time to

prepare additional materials, if necessary, based on comments received during the public meetings. This is in contrast to some suggestions made at the Open Water Meeting to schedule the panel's meetings with industry prior to the public meetings. Statoil also suggested that it might be helpful to hold a poster session, during which each activity could be displayed and people could ask questions.

Recommendations

- (17) The 2011 public Open Water Meeting was 2 days long. This was sufficient time for the companies to present a brief overview of the previous year's activities and the upcoming season's planned activities, and for the companies and the regulatory agencies to receive stakeholder input.
- (18) During the 2012 Open Water Meeting, additional time should be devoted to presentations and discussions of the insights into the impacts (or lack thereof) of exploration and production activities on marine mammals and the spatiotemporal distribution, density, and movements of marine mammals in the Arctic that have resulted from the cumulative body of research that industry has conducted in the Beaufort and Chukchi Seas from 2006 to the present, or since ~2000 for monitoring activities at Northstar production island in the Beaufort Sea.
- (19) The panel meeting should accommodate more time for discussion with the company representatives.
- (20) NMFS and the panel should provide key questions to the companies before meeting with the panel in future years. This will be particularly helpful if the panel has technical questions about the monitoring plans that are best answered by specific technical staff who might not have otherwise been present at the panel meeting.
- (21) NMFS should provide explicit guidelines to the companies regarding what details should be included in the written monitoring plans and presented to the public during the Open Water Meeting.
- (22) NMFS should consider implementing a requirement to have IHA applications submitted by November 1, thereby allowing review of plans prior to March. This would allow both NMFS and industry more time to review and adjust plans prior to the scheduled start of activities.
- (23) NMFS should encourage companies to present an overview of activities planned further than one year into the future, if known.
- (24) NMFS should compile and present a summary table detailing both the authorized and actual estimated takes for the previous year, and the proposed takes for the upcoming season. NMFS should explain how these take estimates relate to "small numbers" of individuals being affected by the permitted or proposed activities.
- (25) NMFS should develop a specific template that the panel would use to assess specific questions about the efficacy and design of monitoring programs for applications for the upcoming open water season. The panel should be directed to review and complete these assessments immediately following the panel meeting and provide those to NMFS so that relatively quick decisions may be made in this regard. The panel should then provide a separate review and recommendations on the overarching/broader issues, along the lines of many of those given here, within six weeks of the Open Water Meeting.

5. COMMENTS AND RECOMMENDATIONS ON SPECIFIC APPLICATIONS

5.1 STATOIL

5.1.1 Are the applicant's stated objectives the most useful for understanding impacts on marine mammals and otherwise accomplishing the goals stated in the paragraph above?

See section 5.1.2, below.

5.1.2 Are the applicant's stated objectives able to be achieved based on the methods described in the plan?

The panelists considered whether the objectives of the monitoring program were “useful” (question in section 5.1.1, above), and simultaneously discussed whether they could be achieved based on the methods described.

In general, the panel thought that the objectives were useful for understanding the impacts on marine mammals. However, there were no objectives focused on understanding how marine mammals would be impacted beyond the line of sight of vessel-based marine mammal observers and beyond the distance at which acoustic recorders can monitor. The panel thought that it is reasonable to add these far-field issues to the objectives and that the proposed monitoring plan would not meet these objectives. The panel also noted that several of the other acoustic sources (in addition to the small airgun array) used in the shallow hazard survey are relatively powerful and operate in the acoustic band of many if not most marine mammals; members of the panel particularly noted the sub-bottom profiler as a concern. To date, NMFS has not required the companies to include these types of sources in mitigation or monitoring plans; thus Statoil did not predict takes nor will they use the effective mitigation zones that incorporate these other acoustic sources during operations. While they are complying with the regulations in this regard, the panel notes that the objectives for mitigation and monitoring are incomplete without considering all elements of an activity with the potential to disturb or harm marine mammals.

Nevertheless, for the stated objectives, the panel generally thought that the specified monitoring plan would be generally effective.

Objective: Provide the basis for real-time mitigation, if necessary, as required by the various permits that Statoil receives. Panel members generally agreed that this objective could be achieved within the 180/190 dB “injury” zone, except during inclement weather or darkness. During those times, MMOs would unlikely be able to observe the entire safety zones.

Objective: Provide information needed to estimate the number of “takes” of marine mammals by harassment, which must be reported to NMFS and USFWS. The panel generally agreed that this objective could be achieved within the 180/190dB zone, with the concern about effective monitoring during darkness or inclement weather noted above, but that there was no effective way to estimate takes beyond the area that could be effectively seen from the vessel. Thus, it was not likely that Statoil would be able to collect data to reliably estimate the number of marine mammals that were actually “taken” by harassment.

Objective: Provide data on the occurrence, distribution, and activities of marine mammals in the areas where the survey program is conducted. The panel generally agreed that this objective could be partially achieved, but only within visual sighting distance of the observers on the vessels, which might not be representative of the occurrence, distribution and activities of all animals that could potentially be affected by the activity.

Objective: Provide information to compare the distances, distributions, behavior, and movements of marine mammals relative to the survey vessel at times with and without airgun activity. The panel

generally agreed that this objective could be partially achieved, but only within visual sighting distance of the observers on the vessels. Broad-scale movements of marine mammals should be investigated within the context of both the Statoil survey vessel and other activities in the area. Because the number of sightings from the seismic survey boat will be small, other sources of information (including passive acoustics and aerial surveys) should be pooled to increase the amount of information that can be incorporated in the analysis.

Objective: Provide a communication channel to coastal communities including Inupiat whalers and other subsistence users. This objective can be achieved provided there is always an Inupiat communicator on the vessel. The vessel-based monitoring program may help to minimize impacts on the subsistence harvest, particularly during crew transfers at villages (e.g., Wainwright) by obtaining updated and accurate information on the status and location of subsistence hunting activities in the area and taking necessary actions to minimize disturbance, but the monitoring plan does not address impacts on subsistence at other times.

Objective: Passive acoustic monitoring. Panel members agreed that the passive acoustic monitoring objectives are appropriate for assessing sound source verification for some of the sound sources on the seismic vessel. However, concerns remained because not all sound sources would be evaluated and the effects of the activities' sounds on animals in the far-field would not be evaluated.

5.1.3 Are there techniques not proposed by the applicant, or modifications to the techniques proposed by the applicant, that should be considered for inclusion in the applicant's monitoring program to better accomplish the goals stated above?

The panel recognized that the current monitoring plan does not propose to address any far-field impacts of the seismic operation. In order to improve the monitoring plan so it would address far-field monitoring, the following should be implemented:

- Use the cluster array to localize whale calls and evaluate the effects of sound on calling animal distribution.
- Conduct sound source verification for the sub-bottom profilers.
- Under specific conditions, conduct aerial surveys to evaluate distributions of whales in the vicinity of exploration and production activities. The industry has expressed concerns related to the safety of manned aerial surveys. If manned surveys are not feasible, other methods for far-field monitoring (e.g., unmanned systems or scout vessels) need to be investigated and, upon approval by NMFS, implemented.
- Consider other new technologies (i.e., underwater vehicles, satellite monitoring, etc.) to assess far-field monitoring.

5.1.4 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?

Review panel members generally re-iterated the recommendations made in last years' panel report, in addition to those listed in section 4.7 above. Furthermore,

- The report should clearly compare authorized takes to the level of actual estimated takes.
- Sightability curves (detection functions) for MMOs should be provided.
- As a starting point for integrating different data sources, Statoil should present their 2010 and 2011 data by plotting acoustic detections from bottom-mounted hydrophone and visual detections from MMOs on a single map.

5.2 ION GEOPHYSICAL

5.2.1 Are the applicant's stated objectives the most useful for understanding impacts on marine mammals and otherwise accomplishing the goals stated in the paragraph above?

See section 5.2.2, below.

5.2.2 Are the applicant's stated objectives able to be achieved based on the methods described in the plan?

The panelists considered whether the objectives of the monitoring program were “useful” (question from section 5.2.1, above) and simultaneously discussed whether they could be achieved based on the methods described. In general, the panel thought that the objectives were useful for understanding the impacts on marine mammals. However, one major shortcoming was there were no objectives focused on estimating actual takes or understanding how marine mammals would be impacted beyond the immediate line of sight of vessel-based marine mammal observers. The panel recognizes the trade-off that ION is attempting to make, working during a time when fewer whales are likely to be present, but the compromise is that there are likely to be so few daylight hours (particularly by the end of the survey) that none of the monitoring objectives will be achievable.

Objective: Provide the basis for real-time mitigation, if necessary, as required by the various permits that ION receives. Panel members generally agreed that this objective could not be achieved due to extended periods of darkness and inclement weather, and presence of sea ice, during the time of year (October to December) in which the proposed activity would occur. The panel discussed whether previous failures of thermal imaging technologies to detect marine mammals, especially cetaceans, should preclude ION's plan to use thermal imaging technologies during the autumn and winter in the Beaufort and Chukchi Seas. Some panel members commented that the winter environment might be very different, and that thermal imaging technologies had been helpful during spring ice seal research in the Bering Sea when seals were on the ice. There was concern expressed about whether thermal imaging systems are able to detect bowheads. The conclusion was that thermal imaging technologies should still be tested by ION during their proposed activities.

Objective: Provide information needed to estimate the number of “takes” of marine mammals by harassment, which must be reported to NMFS and USFWS. Panel members generally agreed that this objective could not be achieved due to multiple factors (e.g., extended periods of darkness, presence of sea ice, inclement weather) that are likely to occur during the proposed time period for the activity.

Objective: Provide data on the occurrence, distribution, and activities of marine mammals in the areas where the survey program is conducted. Panel members generally agreed that this objective could not be achieved under true “baseline,” or undisturbed, conditions; therefore, the resulting data would provide little information for estimating actual takes or understanding potential effects of the activity on marine mammals. Even during the 40- to 60-second periods each hour during which ION plans to not fire the airguns, marine mammals in the vicinity of the operations could potentially be affected by the presence of the vessels and the previous operation of the airgun array. At best, these data will provide information on the occurrence, distribution, and activities of marine mammals that were *detected* by MMOs during the operations; extrapolation to all animals in the area of operations will be extremely unreliable and inappropriate.

Objective: Provide information to compare the distances, distributions, behavior, and movements of marine mammals relative to the survey vessel at times with and without airgun activity. Panel members generally agreed that this objective could not be achieved because the 40- to 60-second periods each hour

during which ION plans to not fire the airguns is too short to consider representative of baseline conditions. However, the panel noted that the acoustic information about the activity that could be gained over the course of the survey when the airguns were shut off would be valuable for post-analysis of this activity and for evaluating future activities. The panel recommended the airguns be turned off for two shots (i.e., 60 seconds) to provide sufficient time to record the background noise associated with the vessels.

5.2.3 Are there techniques not proposed by the applicant, or modifications to the techniques proposed by the applicant, that should be considered for inclusion in the applicant's monitoring program to better accomplish the goals stated above?

ION should deploy overwintering acoustic recorders within their survey area during their eastward transit across the Alaskan Beaufort to the Canadian Beaufort Sea early in the summer. The recorders would monitor sounds during the summer, the seismic shoot, and over the winter. ION should contract someone to return in 2012 to retrieve the instruments and analyze the data. These acoustic data would provide some true baseline information to compare the occurrence, distribution, and behavior of marine mammals at times when ION's activities are occurring and when they are absent. To accomplish this, ION should present a plan for an acoustic monitoring program to an independent expert panel for review. The plan should consider the best placement of the instruments relative to ION's proposed activities, the expected distribution and gradients in marine mammal distribution, and other existing overwintering recorders. There are relatively few data on the distribution and relative abundance of marine mammals in the Beaufort Sea during ION's planned seismic survey. Additional information is needed. Therefore, some panel members thought that ION should conduct aerial surveys in the proposed survey area in October, when there is sufficient daylight to effectively conduct a visual survey, and when belugas, seals, polar bears, and bowheads will likely still be in the area.

ION should also consider changing the survey design to minimize the likelihood of affecting the autumn subsistence whaling and hunting activities. If the western transect lines are critically important to survey, ION should survey them during the open water period, which is prior to the autumn whaling and hunting season and is when more is known about the occurrence, distribution, density, and behavior of marine mammals. It is also when available mitigation methods are most likely to be successful.

If ION does conduct their surveys during the proposed time period, they should establish a communication plan with the hunters. The proposed time period is after the other companies plan to complete their activities, and, therefore, the communication centers are not scheduled to continue operating. ION should wait until the bowhead hunt ends (approximately 20 October) before beginning to survey in the western region of their survey area.

5.2.4 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?

Panel members generally re-iterated the recommendations made in last years' panel report and listed in section 4.7 above. In addition,

- The report should clearly compare authorized takes to the level of actual estimated takes.
- Sightability curves (detection functions) for MMOs should be provided.

6. ACKNOWLEDGEMENTS

Panel members wish to acknowledge and thank Mr. George Noongwook of St. Lawrence Island and Johnny Aiken of Barrow for the information and insights they brought to the panel discussions. Panel members also wish to thank Dr. Robyn Angliss for facilitating the panel's discussion and Ms. Sheyna Wisdom for taking minutes of the meeting.

7. REFERENCES

- Brewer, K., M. Gallagher, P. Regos, P. Isert, and J. Hall. 1993. Kuvlum #1 Exploration Prospect: Site Specific Monitoring Program. Final Report. Prepared by Coastal and Offshore Pacific Corporation, Walnut Creek, CA for ARCO Alaska, Inc., Anchorage, AK.
- Clark, C.W., W.T. Ellison, B.L. Southall, L. Hatch, S.M. Van Parijs, A. Frankel, and D. Ponirakis. 2009. Acoustic masking in marine ecosystems: intuitions, analysis, and implication. *Marine Ecology Progress Series* 395: 201-222.
- Davies, J.R. 1997. The impact of an offshore drilling platform on the fall migration path of bowhead whales: a GIS-based assessment. M.S. Thesis, Western Washington University,
- Hall, J.D, M. Gallagher, K. Brewer, P. Regos, and P. Isert. 1994. 1993 Kuvlum Exploration Area Site Specific Monitoring Program. Prepared for ARCO Alaska, Inc. Anchorage, AK, by Coastal and Offshore Pacific Corporation, Walnut Creek, CA.
- International Whaling Commission. 2007 Report of the 2006 meeting of the Scientific Committee. *Journal of Cetacean Research and Management* 9 (Suppl.); 233p.
- LGL Ltd. and Greeneridge Sciences Inc. 1987. Response of bowhead whales to an offshore drilling operation in the Beaufort Sea, autumn 1986. Report from LGL Ltd., King City, Ontario Canada and Greeneridge Sciences, Inc., Santa Barbara, CA for Shell Western E&P Inc., Anchorage, AK.
- Southall, B. L., Bowles, A. E., Ellison, W. T., Finneran, J. J., Gentry, R. L., Green, C. R., Jr., Kastak, D., Ketten, D. R., Miller, J. H., and Nachtigall, P. E. (2007). "Marine mammal noise exposure criteria: Initial scientific recommendations," *Aquat. Mamm.* 33, 411–522.

8. PANEL MEMBERS

The members of the review panel were:

| | |
|---------------------------|--|
| Harry Brower | Alaska Eskimo Whaling Commission |
| Christopher W. Clark, PhD | Cornell University, Bioacoustics Research Program |
| Megan Ferguson, PhD | National Marine Fisheries Service, National Marine Mammal Laboratory |
| Jason Gedamke, PhD | National Marine Fisheries Service, Office of Science and Technology |
| Brandon Southall, PhD | Southall Environmental Associates, Inc |
| Robert Suydam, PhD | North Slope Borough, Department of Wildlife Management |

Appendix A

Summary of General Recommendations from the 2010 Peer-review Panel Report

1.0 Acoustic effects of oil and gas exploration – assessment and mitigation

- 1.1 NMFS should 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.
- 1.2 NMFS 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.
 - 1.2.1 Recognizing that NMFS may not be able to implement such an approach for mitigation purposes on a real-time basis, for real-time mitigation NMFS may have to continue relying on simple measures that can be readily applied in the field.
 - 1.2.2 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.
 - 1.2.3 Furthermore, NMFS 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).

2.0 Aerial Surveys

- 2.1 Aerial surveys should not be categorically excluded as a research and monitoring tool in the Chukchi Sea.
- 2.2 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).
- 2.3 Monitoring for the purpose of detecting mitigation thresholds (e.g., identifying aggregations or mothers with calves within safety radii) 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.
- 2.4 Those responsible for monitoring with the intent of detecting the effects of certain activities (e.g., seismic surveys, exploratory drilling) 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.
- 2.5 To 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 NMFS.

3.0 Marine Mammal Observers

- 3.1 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.
- 3.2 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.
- 3.3 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.
- 3.4 “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.
- 3.5 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.
- 3.6 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.
- 3.7 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.
- 3.8 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.
- 3.9 NMFS 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.

4.0 Visual Near-field Monitoring

- 4.1 NMFS should require efficacy testing of night-vision binoculars, forward-looking infrared devices, and other such instruments to improve near-field monitoring under Arctic conditions.
- 4.2 NMFS should encourage the industry to consider the use of seismic streamers (passive acoustic technology) 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.

- 4.3 Industry should avoid the use of “sampling” the visual near-field area periodically and then extrapolating to the full survey period. This approach has severe shortcomings and could lead to biased results and conclusions regarding the effects of industry activities.
- 4.4 To help evaluate the utility of ramp-up procedures, NMFS should require observers to record, analyze, and report their observations during any ramp-up period. NMFS 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.

5.0 Visual far-field monitoring

- 5.1 Marine mammal observers should carefully document visibility during observation periods so that total estimates of take can be corrected accordingly.
- 5.2 Aerial surveys should be used whenever possible to supplement the monitoring effort in areas not visible to observers on vessels.
- 5.3 Alternative methods should 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.

6.0 Baseline Biological and Environmental Information

- 6.1 NMFS and the Minerals Management Service [now BOEMRE] should work with the industry to develop more rigorous, longer-term research methods for collecting baseline information before activities are initiated.

7.0 Comprehensive Ecosystem Assessments and Cumulative Impacts

The following is a list 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”:

- 7.1 Emphasize multidisciplinary studies that integrate physical, chemical, and biological measurements to assess human influences throughout marine ecosystems.
- 7.2 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.
- 7.3 Archive all collected data in standardized databases for sharing among scientific disciplines.
- 7.4 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).
- 7.5 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.

- 7.6 Develop better and more timely methods for integrating and displaying combined datasets spatially and temporally.
- 7.7 Include data on location and timing of subsistence hunts.
- 7.8 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.
- 7.9 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).

8.0 Duplication of Seismic Survey Effort

- 8.1 NMFS should work with the Minerals Management Service [now BOEMRE] and other relevant stakeholders to promote and possibly require data sharing to reduce or eliminate duplicative seismic surveys in the Alaskan Arctic. It may be possible that essential seismic information could be collected by a coordinated survey effort rather than by independent and sometimes duplicative efforts.