2013 Expert Panel Review of Monitoring Protocols in Applications for Incidental Harassment Authorizations Related to Oil and Gas Exploration and Development in the Chukchi and Beaufort Seas

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1.0 Introduction

In 1994, Marine Mammal Protection Act (MMPA) section 101(a)(5) was amended to establish an expedited process by which citizens of the US can apply for an authorization to incidentally take (harass, hunt, capture, kill or collect, or attempt to harass, hunt, capture, kill or collect) small numbers of marine mammals by "harassment," referred to as Incidental Harassment Authorizations or IHAs. As required by section 101(a)(5)(D) of the MMPA and the National Marine Fisheries Service's (NMFS) implementing regulations found at 50 CFR Subpart I, IHA applicants must submit a marine mammal monitoring plan as part of their application materials. Where the proposed activity may affect the availability of a species or stock of marine mammal for taking for subsistence purposes, proposed monitoring plans must be independently peer-reviewed prior to issuance of an IHA (50 CFR 216.108(d)).

Each year since 2010, NMFS Office of Protected Resources has convened a panel of experts from academia, government agencies, and private consulting firms with diverse backgrounds in acoustics and marine mammal ecology, particularly with application to arctic conservation and management issues, to review the IHA applications for operations proposed to occur in the Arctic. The 2013 Peer Review Panel consisted of five members with at least two years' experience on the panel and one new member. The 2013 panel was provided with seven IHA applications (including the associated marine mammal monitoring plans) for activities planned in 2013 and 2014 between one and three weeks prior to the scheduled Peer Review Panel meetings. Panelists were asked to review the IHA applications and provide advance questions to the applicants prior to the meetings, which were held on the 8th and 9th of January, 2013, at the National Marine Mammal Laboratory (Alaska Fisheries Science Center, NMFS, NOAA) in Seattle, Washington. The first day of meetings consisted of a sequence of closed-door discussions between each IHA applicant and the panel. During the second day of meetings, the panel re-convened in a closed-door session to discuss all of the applications in preparation for writing separate reports for each applicant and a general report of overarching issues (this document).

Because 2013 was the fourth year in which this format has been used for peer-review, it is instructive to review the 2010 and 2011 panels' recommendations, which are summarized in Appendix A. (The 2012 panel did not create a general report with overarching recommendations.) Some of the previous panels' recommendations have been met, but panelists in 2013 recognized the need for a paradigm shift in the way anthropogenic activities are managed and ecosystem monitoring is conducted in the Arctic in order to shape rather than cede to future changes. The panel identified six elements of this new paradigm for managing and monitoring the arctic ecosystem that must be developed and implemented:

1) A new method for estimating the "take" of marine mammals prior to and after an activity to account for the movement of animals through an area, temporal variability in density, uncertainty in the spatiotemporal distribution of animals, and multiple exposures to individuals;

2) Recommended guidelines for "best practices" for mitigation monitoring;
3) A comprehensive ecosystem monitoring plan for the Arctic;
4) Methods for integrating information to understand cumulative effects;
5) Acoustic exposure criteria that take into account actual impulsive and continuous sound fields generated by seismic sources and continuous sources (e.g., ships, bow thrusters), individually and cumulatively; and
6) Methods for monitoring ice seals.

The remainder of this report reflects the views of individual panel members, which were similar in many but not all circumstances (as noted). Panel members did not strive for consensus. Different perspectives will be indicated hereafter by reference to the views of "some."

2.0 Elements of the New Paradigm for Managing and Monitoring the Arctic

Responsibly and effectively managing and monitoring the Arctic is a complex task that must involve the participation of, and collaboration among, government agencies, experts in Arctic science, and resource users and other stakeholders. There was concern among the panelists that changes related to anthropogenic activities are occurring in the Arctic faster than managers can act, and that the substantial resources (i.e., human, financial, logistical, non-renewable energy) that are currently used to manage and monitor the Arctic are not optimized because the management and monitoring schemes are largely operating in isolation of each other. In order to be proactive and effective, management and monitoring of the Arctic needs to be synoptic and based on the best available information, as outlined in the six elements of the new paradigm discussed below.

2.1 Take Estimates

To "take" a marine mammal, as defined by the MMPA, is to "harass, hunt, capture, kill or collect, or attempt to harass, hunt, capture, kill or collect." Current methods for estimating the number of marine mammals expected to be taken, either by disturbance (Level B) or direct injury (Level A), by an activity are crude, at best. The ability to determine the actual number of animals "taken" during operations is almost non-existent with current approaches in reporting and quantifying marine mammal observations. The *status quo* is to multiply rough density estimates, which are loosely derived from aerial survey data, by the acoustic footprint (the area encompassed by a given isopleth of sound) of the proposed activity. This method has several drawbacks, which raise three concerns about the efficacy of the present method. First, it does not account for animals moving through an area; rather, it is assumed that individual animals are stationary. A take estimate based on this method is biased low if animals are moving through the activity area, such as the case for belugas and bowhead whales that migrate through the northeastern Chukchi and western Beaufort seas each spring and autumn. Second, this method does not account for multiple takes of individuals. In contrast, permits from NMFS that allow take due to scientific research count each instance in which an animal is approached by a vessel or overflown by an aircraft to be a separate take. Third, this method does not account for variability in density due to occasional large groups of animals. This can significantly bias take estimates for belugas, walruses, and bowhead whales whose group sizes have been observed to range from a single individual to hundreds (bowhead whales) or thousands (belugas and walruses) of individuals in the Alaskan Arctic, based on data from aerial surveys.

One solution to account for animals moving through an area is to incorporate a temporal factor in the take calculation; for example, multiplying estimated density by the acoustic footprint and the number of days over which the activity is expected to occur. This approach would also partially address the second concern listed above (multiple takes of individuals) if an individual remains in the area of the activity for more than one day because each day would count as a new take. To address the third concern about group size variability, a take estimate could be presented as a range bounded by minimum and maximum values based on median and maximum observed group sizes in the area, or it could be represented on a continuum by a probability distribution based on the expected frequency of occurrence of each group size.

Recommendations

1. NOAA leadership should take the lead in, and dedicate resources to, the development of guidelines for estimating marine mammal takes for use in IHA applications for, and reports of, permitted activities in the Arctic. These guidelines should be developed in partnership with experts and incorporate the best available scientific information regarding estimates of acoustic exposure and the criteria for assessing cumulative acute and chronic impacts on marine mammals. The guidelines should be flexible enough to accommodate the existing range in the amount and type of information available for any given species, area, and time of year, but they should encompass the issues of accounting for animal movement, multiple takes on individual animals, and group size variability.
2. NMFS should provide IHA applicants with guidance on preparing applications and reporting estimated actual takes in accordance with these take guidelines.

2.2 Best Practices for Mitigation Monitoring

Mitigation monitoring is used to detect when mitigation thresholds have been met and the operator must take some action to prevent or limit Level A takes. For example, if a Protected Species Observer (PSO) conducting mitigation monitoring observes a marine mammal in an acoustic safety zone, the operator may be required to decrease vessel speed, divert the vessel, or call for ramp-downs or shut-downs of a seismic array. Mitigation monitoring is typically conducted only by PSOs stationed on vessels associated with the permitted activity. PSOs can successfully implement mitigation monitoring to a degree (as long as they have the authority to implement mitigation actions when necessary and safety allows) because this typically involves monitoring very near the activity (e.g., within 50-300m). Because PSOs are the first line of defense to prevent Level A takes, it is critical to ensure that the PSOs can effectively monitor the safety radii. However, the Peer Review Panel reports from 2010 and 2011 clearly outlined the difficulties in attempting to conduct mitigation monitoring using only vessel-based PSOs; namely, the inability to: 1) monitor the region where Level A takes could occur that are beyond line-of-sight of the observers (an issue for very loud acoustic sources); 2) observe animals in poor visibility, due to weather or darkness; and 3) identify sightings to species. Several improvements have been made to vessel-based PSO protocols, including the use of data acquisition and archival software by Shell, stationing PSOs on the vessels most likely to have impacts to marine mammals, and positioning PSOs at locations on the vessels that are optimized for sighting animals. Some members of the panel think that mitigation monitoring can

never be achieved by only one PSO on duty at a time because a single person cannot effectively scan the entire safety zone throughout the course of the activity. Increasing the number of PSOs on duty at a time increases marine mammal detection probabilities only up to a point; for example, detection probabilities diminish drastically in darkness and bad weather, regardless of the number of PSOs on duty.

Furthermore, data collected by vessel-based PSOs are not equivalent to data from rigorous scientific surveys, which follow a specific survey design that dictates the sampling strategies necessary to investigate a defined study area. Data from PSOs alone cannot be used to estimate takes, evaluate individual or cumulative impacts of human activities on marine mammals or subsistence activities, or provide baselines on marine mammal distribution, density, movement, or behavior. Finally, in order to remove the hiring, training, oversight, reporting, debriefing, and data management of vessel-based PSOs from the operators, the panel reiterates the recommendation from the 2010 and 2011 panels that NMFS should follow the model used to monitor commercial fisheries, in which observers and observer data are managed by an independent organization.

Monitoring techniques differ in the amount and type of subjectivity and biases that are introduced in the field, and it may be helpful to use methods other than vessel-based PSOs to conduct mitigation monitoring. Data collected by PSOs from a vessel or aircraft are only as good as the PSOs and the protocols they have been instructed to follow. Passive acoustic monitoring could be used to alert the operator to marine mammals that are approaching or within the safety zones. The value of data collected by passive acoustic monitoring depends on the design and placement of acoustic recorders, calling rates of animals (and variability therein), and ability to estimate distance and bearing to calling animals, identify sounds to species, and count the number of animals present. Analysis of acoustic data can be standardized and repeated by multiple independent analysts, thereby allowing for external oversight and removing a component of subjectivity and bias.

Recommendations

3. Vessel-based PSOs should be used primarily for mitigation monitoring within the near-field shut-down zone, and they should not focus on recording animal behavior at the expense of sighting animals.
4. At least two PSOs should be on duty at a time on each vessel conducting an activity with safety radii that cannot be effectively monitored by a single PSO.
5. Vessel-based PSOs should maintain the authority to implement mitigation actions, such as slowing down or diverting the vessel, and calling for ramp-downs or shut-downs.
6. Data collected by vessel-based PSOs are not equivalent to data from rigorous scientific surveys. Vessel-based PSO data should not be considered baseline data on marine mammal distribution, density, movement, or behavior; they should not be considered reliable for estimating marine mammal takes because they likely underestimate the number of animals in the project area; and they do not provide sufficient information to evaluate individual or cumulative impacts of human activities on marine mammals or subsistence activities.

7. Vessel-based PSOs should be managed by an independent organization that conducts observer hiring, training, oversight, reporting, debriefing, and data management.
8. NOAA leadership should take the lead in, and dedicate resources to, the development of guidelines for best mitigation monitoring practices for permitted activities in the Arctic. These guidelines should be based on the best scientific information, and developed in partnership with experts. The guidelines should be flexible enough to apply to the variability in expected species, regions, time periods, and types of proposed activities.
9. NOAA leadership should also take the lead in, and dedicate resources to, the development of guidelines for realistically and adequately conducting far-field monitoring, detecting animals in poor visibility, and identifying observations to species. The guidelines should be based on the best scientific information and developed in partnership with experts.

2.3 Comprehensive Monitoring Plan for the Arctic

The arctic ecosystem is in transition. The increased duration and expanded area of open water has already begun to affect the type, amount, and distribution of anthropogenic activities in the Arctic, facilitating not only oil and gas exploration, development, and production, but also shipping and recreational vessel use. In addition, commercial fisheries are likely to expand into the Arctic, due to increased access to ice-free fishing areas and the predicted northward expansion of ranges of commercially viable fish stocks. In order to enact prudent and responsible management and conservation actions for arctic marine resources, it is necessary to establish a baseline for the current state of the ecosystem and to monitor the ecosystem to understand what, why, and how components of the ecosystem are changing. This will allow better predictions on how the ecosystem is likely to change in the future due to the rapidly changing climate, and potentially provide insight into optimal strategies for managing anthropogenic activities in the arctic ecosystem. Increasing use of sophisticated technologies and dedicated monitoring are required to achieve these goals.

To date, monitoring in the Alaskan Arctic to understand the spatial and temporal variability of the physical, biological, chemical, acoustic and anthropogenic components of the ecosystem has been largely small-scale (with respect to both space and time), disjointed, incomplete, or absent. Some exceptions exist; although the following list is not exhaustive, they include the Aerial Surveys of Arctic Marine Mammals program[1]; Arctic Ecosystem Integrated Survey[2]; Chukchi Sea Environmental Studies Program[3]; and the spring bowhead whale census efforts near Point Barrow, Alaska (Clark et al., 1996; George et al, 2004). For many species, times, and areas, baseline data on the density, distribution and typical activity state(s) are lacking. Some panel members thought that in cases where the scientific baseline data or the mechanisms proposed by the applicant for collecting relevant data are insufficient, there is no scientifically defensible means by which the applicant can justify a proposed activity. One of the most direct and beneficial ways to address this information deficiency is to collect adequate baseline data prior to operations, realizing that the data may be collected while other operations are occurring.

[1] http://www.afsc.noaa.gov/nmml/cetacean/bwasp/index.php
[2] https://web.sfos.uaf.edu/wordpress/arcticeis/
[3] http://chukchiscience.com/

Despite the challenges of obtaining truly "baseline" conditions, the panel considers such monitoring in advance of operations in some dedicated or collaborative manner as a basic responsibility for applicants to conduct offshore operations.

Furthermore, although the MMPA implementing regulations require a monitoring program when applicants are issued an IHA or LOA, there is no encouragement for collaboration among applicants, with outside researchers, or on the international scale; there is no incentive for entities with only short-term interests in the Arctic (such as companies conducting speculative one- or two-year 2D seismic programs) to contribute to long-term monitoring; and there is no scientific guidance on what should be monitored or how the monitoring should best be accomplished.

A long-term, comprehensive, integrated monitoring plan for the Arctic is needed. The plan should: 1) focus on ecologically relevant spatial and temporal scales; 2) be designed to improve our understanding of natural variability and change, and our understanding of anthropogenic effects on the ecosystem; and 3) should include research into acoustic habitat (Moore et al., 2012). Such a plan has numerous advantages over the haphazard system that is currently in place. First, all of the applicants that submitted applications for the panel to review since 2010 have expressed interest in receiving input on what to monitor and how. If a comprehensive plan already existed, companies could buy into components of it without having to develop or contract the expertise to design a study themselves. Second, a comprehensive plan would facilitate collaboration, reduce ineffective or duplicate efforts, and maximize the efficiency of human, financial, logistical, and non-renewable energy resources in studying the Arctic. Third, a comprehensive plan could enhance the ecological value of arctic research efforts through a synoptic study design that explicitly considers the spatial, temporal, and spectral (acoustic) aspects of sampling and the sample sizes necessary to achieve meaningful results. Fourth, a comprehensive plan could address approaches for documenting anthropogenic activities. Fifth, a comprehensive plan could suggest methods for archiving all data, including the appropriate metadata, and making data publically available. Sixth, the information collected from a well-designed plan could provide a solid foundation for investigating cumulative impacts from multiple environmental and anthropogenic variables on ecologically relevant temporal and spatial scales. Finally, a comprehensive plan could facilitate long-term planning for both management and scientific interests, allowing management to be proactive and precautionary rather than reactive.

Recommendations

10. NOAA leadership should take a lead role in developing a comprehensive monitoring plan for the Alaskan Arctic. This task should be undertaken in partnership with experts, including subsistence hunters and fishers, possibly through a workshop or working group. This task involves application of the best available information to:

    a. Identify gaps in data (e.g., sound signatures of every component of anthropogenic activities, animal behavior, spatial and temporal distribution of arctic species, activity logs for anthropogenic activities), information (e.g., species density and habitat use), and understanding of the ecological processes (and variability therein) shaping the Alaskan

Arctic. This gap analysis should consider a breadth of taxa, and not be limited to marine mammals;

b. Create a study design for a comprehensive monitoring plan for the Alaskan Arctic that describes what should be studied, where studies should occur, recommended sampling protocols, and prioritization of the components in the plan. This comprehensive monitoring plan should address the collection of baseline data for, and the spatial and temporal variability of, the physical, biological (including a range of taxa, not only marine mammals), chemical, acoustic and anthropogenic components of the ecosystem;

c. Develop feedback mechanisms in the plan, which would explicitly identify methods for evaluating and modifying the study design and for informing the processes of activity planning and management in the Alaskan Arctic;

d. Identify means for archiving data and the process by which the data could be made publically available.

11. Because anthropogenic activities occurring in arctic waters outside of the US have the potential to affect (directly or indirectly) marine mammals and their prey in US waters, NOAA leadership should actively seek support for, and expansion of, the comprehensive monitoring plan for the Arctic at the international level.

2.4 Integration of Information to Understand Cumulative Effects

The issue of assessing the potential effects on marine mammals of cumulative noise and other stressors from multiple, ongoing anthropogenic activities has been problematic, especially in the context of a rapidly changing Arctic.

Over the past two years, with support from BP Alaska, the North Slope Borough, and many individuals, a group of scientists with expertise in physical and biological acoustics, marine mammal audition, arctic marine mammals, and North Slope subsistence needs has been working to develop an approach for quantifying cumulative noise from multiple types of industry sound sources and for evaluating the potential impact of the cumulative noise field on bowhead whales. In September 2012, a paper on this effort was presented at the Society of Petroleum Engineers/Australian Petroleum Production and Exploration Association International Conference on Health, Safety and Environment in Oil and Gas Exploration and Production in Perth, Australia. This project, along with several others (e.g., NOAA's Sound Field Mapping project; Germany's Criteria and Development of a Model to Assess Interference Potential through Masking in the Use of Airguns in Antarctic Waters) and emerging papers (e.g., Ellison et al. 2012; Hatch et al. 2012) on this topic have begun to define the necessary considerations for quantifying cumulative noise fields and potential influences of chronic noise exposures on endangered species.

Although progress is being made on the issue of cumulative ocean noise, the process of cumulative noise assessment has not been formalized and cumulative noise assessments have not been adequately

completed. Progress on this fundamental problem has been due to lack of: a) a basic process by which to analytically merge the noise fields from multiple sources, some of which are impulsive and some of which are continuous or both; b) identification of responsibility for coordinating and collecting all the data necessary to compute cumulative noise metrics; c) a mechanism for translating the physical acoustic results into biological impact(s); and d) identification of responsibility for conducting the cumulative noise assessment -- Is it the responsibility of individual IHA applicants, an independent party, or the regulatory agency?

The panel recommends two processes be implemented to enable cumulative noise assessment. The first involves the mechanics of calculating cumulative noise fields over ecologically appropriate spatial, temporal and spectral scales. The second involves the translation of those noise fields into a biological impact, effect or influence.

Calculating the dynamics of cumulative noise fields requires datasets from all noise-generating activities associated with each operation. These project-specific datasets should include the information necessary to calculate representative noise maps of the spatial, temporal and spectral dynamics of cumulative noise. For every activity that is part of an application these would include the following project-specific datasets in standardized format:

- Sound source verification results for all noise-generating activities for which there are not acceptable representative source characteristic data available;
- Time-stamped location data for all sound sources.

Estimating the biological and ecological impacts of the resultant cumulative noise fields is the more difficult task and one that plagues the biological evaluative process. It requires knowledge of such things as the auditory capabilities of the species (presently poorly known for mysticetes), the biological context (e.g., migrating, feeding, breeding) under which the exposure occurred, and spatiotemporally explicit information on the distribution and density of all species of concern (e.g., marine mammals and their prey).

Finally, the panel recognizes that additional potential stressors to marine life (particularly marine mammals and their prey) and to the natural environment must be considered for a cumulative impacts assessment to be complete. Examples of additional variables to consider include the physical presence of infrastructure and support vessels associated with anthropogenic activity in arctic waters, discharge from exploratory drilling and ballast water, and biological, physical, chemical changes due to climate change.

Recommendations

12. NOAA leadership should take a lead role in finding a functional solution to monitoring and understanding the Arctic's acoustic environment on realistic space and time scales. This should be done in partnership with experts in physical and biological acoustics, and could be modeled after NOAA's Underwater Sound Field Mapping Working Group. This task requires:

    a. Establishing standardized mechanisms for collecting empirical data on individual noise sources;

b. Continuing to build analytical tools by which to calculate cumulative noise fields from combined activities (e.g., cumulative noise from a long-duration seismic airgun survey interacting with vessel noise);

c. Building and maintaining a database of empirical data and resultant noise field data;

d. Expanding considerations of potential noise impacts to include chronic influences from cumulative, long-term exposure;

e. Building risk metrics that take into account the best available scientific evidence showing that as a seismic impulse propagates farther and farther from the seismic source through the Arctic Ocean, it changes considerably such that it becomes less and less impulsive, and its energy spreads into and fills in the time gap between the original impulses.

13. NOAA leadership should take a lead role and work with experts, including subsistence hunters and fishers, to formulate an analytic procedure by which to adequately consider the potential cumulative biological impacts of large spatial and temporal scale increases in background noise levels and other stressors on arctic marine life, particularly marine mammals and their prey. This task could involve a workshop or working group, and should be based on the best available information.

2.5 Acoustic Exposure Criteria

Much of the panel's deliberation regarding the proposed activities and accompanying mitigation measures focused on how best to understand and reduce the potential negative effects of noise and associated activities on marine life. Negative effects of noise include discrete or acute effects from a single sound source and chronic effects from activities that overlap and interact over large spatial and temporal scales. Activity-specific monitoring plans are designed to assess discrete or acute effects, such as permanent threshold shift or local changes in distribution, due to single sound sources. Activity-specific monitoring plans have not been designed to assess chronic effects, such as physiological stress, decreased reproductive rates, loss of foraging opportunities, and disruption of social behavior, that could result from living in an environment that contains noise and other stressors from multiple anthropogenic activities that are variable in space and time and that may have acoustic footprints that span ocean basins. The panel understands the need to consider both acute and chronic noise issues and addressed necessary progressions in acoustic criteria regarding both issues.

One of the most important recommendations by the panel members is that NMFS initiate a transition away from using a single metric of acoustic exposure (i.e., a step-function sound pressure level) to estimate the potential acute effects of anthropogenic sound on marine living resources. In terms of assessing potential impacts, marine mammals are best considered as living within dynamic acoustic environments that, among other things, vary over time, space, frequency, sound level, and directionality. The term "spatial-temporal-spectral variation" has been used to indicate this 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). 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 combined influences of a suite of potentially co-varying physical and biological factors (Ellison et al., 2012). Furthermore, there may be significant variability among individuals that is impossible to predict or describe with a step-function threshold, regardless of the metric. 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.

For real-time mitigation, in which operational conditions require straightforward measures for mitigating the risk of acute effects from anthropogenic sound, NMFS should continue to rely on simple measures that can be readily applied in the field. However, these simple measures should be based on more comprehensive ecosystem assessments that consider the cumulative effects of noise (see section 2.4, Integration of Information to Understand Cumulative Effects), the animal's activity state (e.g., feeding, migrating, reproduction), other stressors, and the environment in which the activity occurs; furthermore, they should be precautionary to compensate for remaining uncertainty in potential effects. For example, NMFS 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, 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 resulting propagation effects of sound at distance, and the relevant biological circumstances (e.g., species present, migration versus reproductive seasons). NMFS has started to move in this direction by applying different sound exposure thresholds for intermittent versus continuous noise and for different groups of animals. Further progress in truly 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.

Recommendations

14. NMFS should initiate a transition away from using a single metric of acoustic exposure (i.e., a step-function sound pressure level) to estimate the potential acute effects of anthropogenic sound on marine living resources.
15. For real-time mitigation, in which operational conditions require straightforward measures, NMFS should continue to rely 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.

2.6 Methods for Monitoring Ice Seals

Ice-associated seals (bearded, ringed, spotted and ribbon seals) pose special problems for estimating levels of harassment resulting from anthropogenic activities in the Chukchi and Beaufort seas. The current practice of applying historical estimates of ice seal densities or abundances to the areas expected to be ensonified at a particular dB level is flawed in at least two ways. First, historical estimates of ice seal abundance were either calculated from surveys of seals hauled out on sea ice in the spring, or of seals in the water during the ice-free period in summer. Springtime surveys benefit from the high probability of detecting a seal on the ice (e.g., high contrast of a dark seal against a background of white ice) and identifying the seal to species, and the ability to use Satellite Data Recorders (SDRs) to estimate the proportion of seals in the water during the surveys to create correction factors for animals not seen. All ice-associated seals are highly migratory, however, so abundance estimates derived from surveys of seals hauled out on ice are valid only for the springtime. Surveys during the ice-free period in summer allow for sighting seals during the time of most anthropogenic activities, but SDRs cannot be used reliably to estimate the amount of time a seal is at the surface. Further, the probability of detecting a seal or identifying it to species is very low (e.g., low contrast of a dark head against a background of dark water). Indeed, it is so low that operation platform- or vessel-based observers can rarely identify seals within or beyond the range of the presumed impact of the anthropogenic noise they are investigating.

The second flaw in the current method of estimating takes of ice-associated seals results from a complete lack of knowledge of the auditory thresholds and impacts or behavioral responses of ice-associated seals to underwater noise. Currently the MMPA applies the same dB levels for harassment developed for whales to all four species of ice-associated seals. This is done for convenience and has no scientific basis. It is possible, as noted in some of the IHA applications, that ice seals have a very high tolerance or threshold for noise, as industry PSOs have reported the presence of many seals very close to operating platforms and vessels. Yet it is also possible that more seals are observed near these sound sources because they are “escaping” the underwater noise by remaining longer at the surface. Either behavior would bias the results from any surveys conducted near an operation, or from platforms or vessels on which the operation is based, but without the proper research it is impossible to know how to adjust for the bias.

Therefore, the panel recognized that it is currently impossible or impractical to accurately estimate the densities or abundances of ice-associated seals during the open water season. Furthermore, without research on the auditory thresholds and responses of each species to pulsed and continuous underwater

sound, it is also impossible to accurately estimate the number of ice-associated seals harassed or injured by anthropogenic noise.

Recommendations

16. Requesting and reporting unreliable and biased estimates of harassed seals is not a useful approach to quantifying the impacts of open water operations on ice-associated seals. Until there is a better approach for obtaining accurate take estimates, the panel recommends that applicants either request an unlimited number of Level B takes or request permission to harass the entire populations of bearded, ringed, spotted and ribbon seals in the Beaufort and Chukchi seas.
17. Given the past experiences of PSOs, monitoring for Level B takes of ice-associated seals seems unlikely to provide much additional useful information. Monitoring for Level A takes, however, should remain mandatory.
18. The panel recommends that all parties (e.g., government, industry, academia, and private researchers) consider conducting, or directly contributing to, the critical areas of research necessary to allow for the accurate estimation of ice-associated seals impacted by anthropogenic noise. Examples of critical research include:
    a. Captive studies on the auditory thresholds (behavior, etc.) of all species, including questions of cumulative effects and masking;
    b. Studies of behavioral impacts of sound using animal-borne sound recorders and SDRs;
    c. Development of methods for accurately estimating the abundances and distributions of ice-associated seals during the open water period;
    d. Identification of the seasonal habitat use and haul-out behavior (for correction factors) of all species through the use of SDRs.

3.0 Other Issues

Panel members emphasized the need to schedule the Peer Review Panel meetings for a time when sufficient information from the companies exists to critically review the IHA applications. Most importantly, an IHA application should contain an attainable, defensible, and detailed marine mammal monitoring plan for the panel to review as a group. The review should occur enough in advance of the proposed operations for a company to revise their monitoring plan, as necessary, but not so far in advance to unnecessarily have the panel review plans that are later withdrawn. Panel members thought that the scientific integrity of the IHA review process should not be sacrificed in order to meet a company's individual timeline. If an IHA application does not meet the standards of what is required for a thorough review, or is not delivered to NMFS Office of Protected Resources in time for review for the upcoming year, the application should be put on hold until the next round of Peer Review Panel meetings when it can be evaluated in its entirety by all panel members.

4.0 Acknowledgements

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5.0 References

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6.0 Panel Members

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Appendix A

Recommendations from the 2010 and 2011 Peer Review Panels.

2010 Peer Review Panel Recommendations

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 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. Realtime 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 ogranizations, 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.

2011 Peer Review Panel Recommendations

GENERAL COMMENTS

(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.

ACOUSTIC EFFECTS OF OIL AND GAS EXPLORATION – ASSESSMENT AND MITIGATION

(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 spatiotemporal 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.

MARINE MAMMAL OBSERVERS

(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.

COMPREHENSIVE ECOSYSTEM ASSESSMENTS AND CUMULATIVE IMPACTS

(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.

IMPROVING TAKE ESTIMATES AND STATISTICAL INFERENCE INTO EFFECTS OF THE ACTIVITY

(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.

IMPROVING THE PEER-REVIEW PROCESS

(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.