

Discussion Questions for Marine Mammal and Sound Workshop

Instructions for Discussion Sessions

As a reminder, you will be seated in an assigned group of 7 or 8 people that will include scientists and policy folks from both governmental and non-governmental groups. Each table will have a designated recorder who is not a workshop participant.

In the interest of ensuring that every question gets addressed by at least one group:

- For sessions A and C, each table will be given one required question from the list, and then each table will choose 1 or 2 additional questions to address.
- For sessions B and D, each table will be given two required questions from the list, and then each table will choose 1 or 2 additional questions to address.

Once you are discussing a question, if there are facets of the issue at hand that you think are important to explore in this forum that are not addressed in the question, please feel free to pursue them and report back to the group.

In order to ensure adequate discussion time for the chosen questions, we will also ask that you please choose the questions that the group will be addressing at the beginning of the discussion period and identify a tentative amount of time for the discussion of each.

Question Topic Overview

A. Biologically significant effects of sound exposure: baseline data and assessment

- (1) Basic Biological Research for Representative Marine Mammal Species
- (2) Standardized Marine Mammal and Sound Database(s)
- (3) Predictive Tools for Density/Distribution Estimation
- (4) Acoustic Behavioral Response Research for Representative Marine Mammal Species
- (5) Non-Behavioral Responses to Sound
- (6) Biologically Significant Impacts

B. Understanding and Reducing Sound Generation and Propagation

- (1) Sound Source Identification and Review
- (2) Ambient Noise
- (3) Quieting Technologies
- (4) Cumulative Contributions of Multiple Sound Sources to Marine Noise
- (5) Sound Propagation Prediction Tools
- (6) Standardized Marine Mammal and Sound Database(s)

C. Acoustic Behavioral Harassment Criteria, Methodologies for Cumulative Effects Analysis and Mitigation

- (1) Acoustic Behavioral Harassment Criteria

- (2) Masking
- (3) Cumulative Impacts Assessment
- (4) Mitigation
- (5) Monitoring Methods

D. Improving Monitoring Techniques (Technology and Methodology)

- (1) Algorithms (by category/DCLD)
- (2) Processing Hardware
- (3) Platforms/sensors (Fixed/Portable)
- (4) Information Sharing
- (5) Current/Emerging Monitoring Technologies

Discussion Questions

A. Biologically significant effects of sound exposure: baseline data and assessment (Session Chair- Southall)

(1) Basic Biological Research for Representative Marine Mammal Species

Many reports have listed areas where we are missing important *basic* physiological, behavioral (baseline), density/distribution, and longitudinal life history data for representative marine species (such as common species) and key species (ESA-listed and sound sensitive species, i.e., those that seem to react to sound at comparatively lower received levels or are historically more likely to be associated with strandings).

- What are the most important basic biological data needs for better understanding and management of biologically significant effects of exposure to sound that need to be met in the next 2-3 years?
 - Why?
 - Who should perform these studies, what are the cost estimates and how will they be funded?
 - How long is it likely to take to meet these most important data needs at a level of resolution/certainty required for management, i.e., can they be accomplished with one discrete study or will they necessitate long-term governmental support to be useful to management (show variation over seasons/larger areas etc.)?
 - If these essential data gaps were not bridged in the near future due to lack of funding or governmental investment, what are some options for resource agencies to manage species conservatively in the face of the specific types of uncertainty that these data gaps generate?

If there are other important issues under this topic, please address those also.

(2) Standardized Marine Mammal and Sound Database(s)

There have been many discussions about creating a standardized marine mammal database and requiring that all parties/agencies holding permits or authorizations be required to electronically enter any data collected into that government-run database. This data could then be systematically archived, analyzed, and made available to resource managers, researchers, and the public. Without getting into a discussion of who should fund this and which government agency would house it (although, with the intent of informing these issues) please consider the following:

- What are some of the logistical needs to make this happen (e.g., data clearance/proprietary issues, communication among agencies with access to data and/or expertise in managing data etc.)?
- As a potential user of this database, how would you use this resource if it existed (e.g., all visual sightings made during construction projects in Puget Sound over 10 years, sound source verification data from Arctic oil and gas seismic vessels) in research and/or environmental impact assessment contexts?
- How could these types of data be integrated with (or used in meta analyses with) more standardized or systematically collected data to inform understanding of distribution, abundance, and/or behavior?
- In light of your responses to the last 3 bullets, list the high-priority issues that need to be taken into consideration in the development of a standardized database to maximize its utility.
- Some government agencies may have existing but currently under-utilized datasets that could be made available to aid in the analysis of biologically significant effects of sound exposure. List any these datasets (of marine mammal data) that you are aware of, by agency, and indicate what type of data (e.g., basic information on distribution or abundance, data on potential effects, sound source characterization data) is contained in the dataset, as well as the general format and standardization of raw and metadata. What needs to happen to make the data more readily available (e.g., are certain protocols existing, or necessary to design)?

If there are other important issues under this topic, please address those also.

(3) Predictive Tools for Density/Distribution Estimation

- What existing tools (or tools in development) can be effectively used to estimate/predict marine mammal density and distribution for under-surveyed areas of the world's oceans? What oceanographic, biological, and other environmental features (if any) are effectively considered in these predictive tools?
- Can we systematically identify specific sets of circumstances in which the use of these sorts of tools would be expected to be either more or less likely to result in accurate results?
- What should be done to achieve standardized applications and acceptance for these tools?

- What are the pros and cons of incorporating such tools into a standardized national system that would be applied in management decisions (such as the one contemplated for housing all marine mammal monitoring data).

If there are other important issues under this topic, please address those also.

(4) Behavioral Response Research for Representative Marine Mammal Species

As we can see by looking at the Southall et al. (2007) compilation of data, we are missing important pieces of information showing how specific marine mammal groups (representative marine species: such as common species and key species: such as ESA-listed and sound sensitive species) respond to specific types of sound sources/activities (not to mention in different contexts or at what different received levels).

- What are the most important specific behavioral response to anthropogenic sound data needs for better understanding and management of biologically significant effects that need to be met in the next 2-3 years?
 - Why?
 - Who should perform these studies, what are the cost estimates and how will they be funded?
 - How long is it likely to take to meet these most important data needs at a level of resolution/certainty required for management, i.e., can they be accomplished with one discrete study or will they necessitate long-term governmental support to be useful to management (areas achieve threshold sample sizes, repeat experiments, alter ecological/environmental conditions etc.)?
 - If these essential data gaps were not bridged in the near future due to lack of funding or governmental investment, what are some options for resource agencies to manage species conservatively in the face of the specific types of uncertainty that these data gaps generate?
- How should representative species best be used for predicting the behavioral responses of other species based on the information we have in-hand? For example, should this concept be based on taxonomy, hearing sensitivity (by frequency), or similarities in life history?
- What are the most important laboratory/captive based experiments and/or theoretical modeling (i.e. no field component) projects needed, and why?

If there are other important issues under this topic, please address those also.

(5) Non-Behavioral Responses to Sound

- Should there be an increased focus on the effects of noise stress and immune function studies? If yes, keeping in mind both acute and long-term exposures, what are the most important studies that should be conducted and why?

- What are the most important data gaps in our understanding of how to best assess specific types of non-auditory tissue damage in animals exposed to anthropogenic sound? Why and, separately, will they directly inform current management decisions?

What are the most important data gaps in our understanding of how to best assess auditory tissue fatigue/damage in animals exposed to anthropogenic sound? Why and will they directly inform current management decisions?

If there are other important issues under this topic, please address those also.

(6) Biologically Significant Impacts

What is a biologically significant impact (to an individual or a population)? How is it quantitatively identified?

- How do we realistically and consistently determine which effects may be discounted as insignificant in a decision-making context?
- How well do the NRC recommendations regarding effects on foraging, survival, and reproduction match the available data on behavioral effects? Are these the correct criteria for the determination of biologically significant impacts?
- Are there particular contextual factors about sound exposure (e.g., similarity of sounds to those of predators) that are more likely to result in biologically significant impacts?

If there are other important issues under this topic, please address those also.

B. Understanding and Reducing Sound Generation and Propagation (Session Chair-Hildebrand)

(1) Sound Source Identification and Review

Please refer to the attached spreadsheet which lists: types of anthropogenic sound that contribute notably to the soundscape; U.S. acoustic data sets that can help characterize sound fields affected by these sounds (broadly, e.g., shipping lanes); the agency/organization that holds those datasets, whether or not the specific sources have been specifically characterized, and the reference:

- Is anything missing or incorrect?
- What are the most important data needs (and why?), each, for characterizing acoustically:
 - individual sources
 - understanding broad use of the source type
- Are there similar data sets available outside of the U.S. Government that would provide valuable sound field characterization information? Is there sufficient reason to push for releasing this data?

If there are other important issues under this topic, please address those also.

(2) Ambient Noise

What acoustic datasets are available for measured ambient noise? What are the needs for longitudinal measurements of ambient noise? How should we standardize collection of that data? How do we prioritize the areas in which ambient noise measurements are most needed? What are the important uses of ambient noise data in a management context?

If there are other important issues under this topic, please address those also.

(3) Quieting Technologies

Different groups are working on ways to quiet shipping noise and quieter alternatives to seismic airguns for oil and gas surveys. Are there other activity types in which economically feasible improvements have been/could be made to reduce the amount of energy introduced into the water to accomplish the given goal (i.e., quieter ways to build a pier or detect an enemy submarine)?

(4) Cumulative Contributions of Multiple Sound Sources to Marine Noise

How do we best evaluate multiple specific sources and their cumulative contributions to marine noise?

If there are other important issues under this topic, please address those also.

(5) Sound Propagation Prediction Tools

What tools are currently available (or will be available in near future) to resource managers and the public to model sound propagation? How do these tools compare in ease of use and accuracy of output? Have they been validated?

If there are other important issues under this topic, please address those also.

(6) Standardized Marine Mammal and Sound Database(s)

There have been many discussions about creating a standardized marine mammal database and requiring that all parties/agencies holding permits or authorizations be required to electronically enter any data collected (which will sometimes include sound source verification information and could also include other sound source information) into that government-run database. This data could then be systematically archived, analyzed, and potentially made available to resource managers, researchers, and the public. Without getting into a discussion of who should fund this and which government agency would house it (although, with the intent of informing these issues) please consider the following:

- What are some of the logistical needs to make this happen (e.g., data clearance/proprietary issues, communication among agencies with access to data and/or expertise in managing data etc.)

- As a potential user of this database, how would you use this resource if it existed (e.g., all visual sightings made during construction projects in Puget Sound over 10 years, or the sound source verification data for seismic airguns in the Arctic) in research and/or environmental impact assessment contexts?
- How can we standardize source characterization and measurements (at least within certain large frequency bands) so that comparisons among sources are meaningful in the context of evaluating impacts to marine mammals?
 - For example, the ASA Standards Committee S12/Working Group 47 has produced a document, "American National Standard Quantities and Procedures for Description and Measurement of Underwater Sound from Ships- Part 1: General Requirements" (ANSI/ASA S12.64-2009/Part 1), and similar efforts are under way within the International Standards Organization (ISO/TC8SC2) regarding the characterization of underwater noise, specifically for merchant ships. Should the ANSI standards be adopted as a standard for sound source verification (SSV) test when vessel noise is involved? Or should we wait for the ISO standards and make a decision which one is the most appropriate to be used in addressing shipping noise? Why?
 - Are there other existing standards that we should consider adopting? What are the pros and cons of doing so?
- Are there existing datasets describing specific propagation environments (e.g., SVP, boundary condition, transmission loss spectra, etc.)? Is the information accessible to researchers and resource managers?
- Some government agencies may have existing but currently under-utilized datasets that could be made available to aid in the analysis of biologically significant effects of sound exposure. List any of these datasets (of sound source characterization or propagation data) that you are aware of, by agency, and indicate what type of data (e.g., basic information on distribution/abundance, data on potential effects) is contained in the dataset, as well as the general format and standardization of raw and metadata. What needs to happen to make the data more readily available (e.g., are certain protocols existing, or necessary to design)?

If there are other important issues under this topic, please address those also.

C. Acoustic Behavioral Harassment Criteria, Methodologies for Cumulative Effects Analysis and Mitigation (Session Chairs – Harrison and Hatch)

(1) Acoustic Behavioral Harassment Criteria

Thinking outside of any boxes (i.e., do not limit thoughts based on questions below), what are some alternative methods (with their pros and cons) for structuring and implementing acoustic criteria for behavioral harassment? For example:

- Dose/response curve versus step function based on received level

- Estimating sound fields on a project-by-project basis vs. setting up standard isopleths for different activity types/depths/bathymetry
- If dose/response curve, how derive? – LOGIT, etc.
- Quantitatively, and more comprehensively, incorporating the consideration of additional contextual factors such as distance from the source, directionality/predictability of source movement (i.e., additional factors beyond received level).
- Classifying general categories of noise differently, for example (1) impulse; (2) non-impulse continuous (such as drilling or any source that is continuously run for an appreciable duration at one location); and (3) non-impulse transient (such as vibratory pile driving, shipping, or any source that runs intermittently or runs continuously but does not stay at one location) – OR, maybe it should be by activity type instead of these broader categories? OR, sounds classified as predators?

Acknowledging the large role that context of exposure plays, how should hearing sensitivity (by frequency) be quantitatively taken into account in predicting marine mammal *behavioral* responses to sound?

If there are other important issues under this topic, please address those also.

(2) Masking

How can we quantify the biological (fitness) consequences of signal masking in order to understand the costs of noise interference with communication, the locating of prey, predator avoidance and hearing environmental cues in marine animals? How should we seek to manage relatively lower level (below current exposure thresholds) changes in ambient noise resulting from regular human activities that are, nevertheless, changing the acoustic ecology for marine animals that rely on sound to live?

If there are other important issues under this topic, please address those also.

(3) Cumulative Impacts Assessment

How do we integrate information about how animals are responding to noise with information about how they are responding to the more realistic multi-stressor environments that they are exposed to either during a short-term permitted activity and/or in the increasingly urbanized coastal ocean?

- Context is critical, and context is not just noise, it is pollution, abundance of food, mate availability, chemical pollution, new transient vessel activity and many other things. How do we integrate noise with information about the full environment the animal is exposed to in order to evaluate effects effectively?
- Please recommend a framework for considering the interaction of multiple stressors (acute and chronic) in the context of conservation management decisions.

- What additional data can be being collected when doing marine mammal research or monitoring of sound effects that could be used to inform cumulative impact assessments? Which of these additional data collection efforts would be easy, medium, or difficult? Inexpensive, medium, or expensive?

If there are other important issues under this topic, please address those also.

(4) Mitigation

- Regarding typical basic mitigation measures (i.e. exclusion zones, monitoring of exclusion zones, power-down or shutdown within exclusion zones, or ramp-up) intended to avoid exposing animals to sound levels associated with TTS, PTS, or more severe behavioral responses:
 - What evidence is available indicating these measures are effective at accomplishing the goal above?
 - How would you design a study to evaluate the effectiveness of current mitigation measures?
 - Are you aware of real-time ways to improve/augment these measures to better accomplish the above goal using methods or technologies that are available today and considering the characteristics/goals of the proposed activity?
 - What kinds of potential effects (e.g., auditory masking from chronic sound sources) may conventional approaches miss in terms of mitigation
 - Based on existing evidence, what are the pros and cons of focusing mitigation measures primarily on avoiding exposure to very high levels (at close distances) that would likely be associated with more severe impacts versus avoiding other kinds of impacts that may be less immediately severe but more widespread?
- How do we best incorporate information about noise exposure into siting/ocean use decisions in general? For example, based on the existing evidence, what characteristics of marine mammal use would suggest that an area should be considered for limiting sound-producing activities, (e.g., breeding/calving, feeding, high density, etc.). What information exists to support the effectiveness (in terms of reducing quantity or severity of effects) of limiting activities in these scenarios?
- For the purposes of both better analysis and mitigation development, is there evidence of specific acoustic exposure conditions that have been linked to more adverse effects (e.g., the way that the Navy has generally characterized the steep bathymetry and multiple vessel factors that have been present in most of the stranding events that have been associated with naval exercises)? Or, if scientists suspect such an association, but supporting data are limited, how could we design a study to answer these sorts of questions?

If there are other important issues under this topic, please address those also.

(5) Monitoring Methods

How should we design and prioritize monitoring studies, in the context of regulated activities, to both: 1) better understand the acoustic signatures and acoustic behavior of sources and species, respectively associated with the authorized activity and area, and, as appropriate and needed, 2) provide information that will help fill broader identified data gaps (background noise variation in a region, animal distribution/density in a region, response of species to sources of different types under different conditions etc.) or 3).

- What is the most important type of information that monitoring programs should gather? Why?
 - Describe how the focus should shift in different circumstances (e.g., for longterm activities vs. shortterm, for activities in areas with little available marine mammal baseline information vs. areas with substantial information).
 - Describe some methods/study designs that could be used to efficiently gather the data prioritized above (specify method, not just technology used). Estimate how long these methods take to implement (from deployment of equipment through analysis of data and finalization of reports) and compare how much they cost, grossly (low, medium, high – or some other system).
 - Should NMFS convene a panel of experts to design a national monitoring strategy specifically targeted at filling some of the data gaps identified in this workshop? Focus of this group would be to recommend methodologies pursuant to a wide array of regulated activities that would take into consideration varying resources (money, capacity and infrastructure) among regulated parties while ensuring consistency in overall approach and goals among monitoring programs. Why or why not?

If there are other important issues under this topic, please address those also.

D. Improving Monitoring Techniques (Technology and Methodology) (Session Chair- Moretti)

(1) Algorithms (by category/DCLD)

- a. What are the basic requirements?
- b. Given these perceived requirements, what are the areas (by category/DCLD) that require significant improvement?
- c. What basic data are required for development?
- d. What methods can be used to verify performance?
- e. Suggested methods for data gathering?
- f. Isolate current shortfalls in methods and technology.
- g. How can the necessary data be most efficiently shared across organizations and between developers

If there are other important issues under this topic, please address those also.

(2) Processing Hardware

- a. What are the areas of need for processing hardware?

b. What are the current gaps in processing hardware?

If there are other important issues under this topic, please address those also.

(3) Platforms/sensors (Fixed/Portable)

- a. Summarize the perceived requirements
- b. Summarize the current available platforms and sensors.
- c. What are the current gaps in processing platforms and sensors? Priorities?

If there are other important issues under this topic, please address those also.

(4) Information Sharing

Suggest methods of improving the dissemination/sharing of information (algorithms/hardware/methodologies).

If there are other important issues under this topic, please address those also.

(5) Current/Emerging Monitoring Technologies

What technologies are available now or near future for real-time vs. archival data collection from monitoring/mitigation systems (PAM, active acoustics, radar, infrared imaging, underwater gliders, etc.)?

- What systems can be used now to inform real time management and how can they be improved (i.e., make them more cost effective, more available, more efficient etc)?
- What are the most effective systems for covering long time series and large spatial scales and generating archival data to inform time/area closures or other pre-set mitigation designs and how can those be made more cost effective/available?
- What are the anticipated benefits and drawbacks of using active acoustic methods for detection of marine mammals for mitigation implementation or monitoring (e.g., avoiding certain effects, but potentially creating an acoustic impact) – what are the existing studies?

If there are other important issues under this topic, please address those also.