Ocean Noise Strategy Roadmap Executive Summary

INTRODUCTION

Increasing human activity, along more of the earth's coastlines and extending farther offshore in deep ocean environments, is leading to rising levels of underwater noise. Increasing noise levels are impacting the animals and ecosystems that inhabit these places in complex ways, including through acute, chronic, and cumulative effects. In the U.S., the National Oceanic and Atmospheric Administration (NOAA) is the federal agency that holds the most responsibility for protecting aquatic animals and their habitats, through a variety of legal mandates. NOAA's approach towards further understanding and managing underwater noise should be multi-faceted. Numerous studies illustrate specific adverse physical and behavioral effects that exposure to certain sound types and levels can have on different species. Additionally, sound is a fundamental component of the physical and biological habitat that many aquatic animals and ecosystems have evolved to rely on over millions of years. In just the last ~100 years human activities have caused large increases in noise and changes in soundscapes.[1] These changes can lead to reduced ability to detect and interpret environmental cues that animals use to select mates, find food, maintain group structure and relationships, avoid predators, navigate, and perform other critical life functions. Therefore, NOAA's management goals and actions should aim to address chronic effects and conserve the quality of acoustic habitat[2] in addition to minimizing more direct adverse physical and behavioral impacts on specific species.

Here, we present the NOAA Ocean Noise Strategy (the 'Strategy') Roadmap. This document is designed to support the implementation of an agency-wide strategy for addressing ocean noise over the next 10 years. The Roadmap highlights a path to expand NOAA's historical focus on protecting specific species by additionally addressing noise impacts on high value acoustic habitats. Fundamentally, the Strategy Roadmap serves as an organizing tool to rally the multiple NOAA offices that address ocean noise impacts around a more integrated and comprehensive approach. A series of key goals and recommendations are presented that would enhance NOAA's ability to manage both species and the places they inhabit in the context of a changing acoustic environment. The Strategy Roadmap is not intended to be a prescriptive listing of program-level actions. Instead this document is intended to provide a cross-line office roadmap summarizing some of the essential steps that could be taken across the agency to achieve the Strategy's goals for more comprehensive management of noise impacts.

The information and guidance included in the Roadmap can strengthen the abilities of regulatory and science programs addressing noise impacts (including those with noise-producing operations) to meet their existing strategic goals and plans. Some recommendations suggest actions that could be taken by individual programs within the agency, while others highlight opportunities for parallel activity or partnerships among multiple programs. Crafting and implementing modernized management approaches that balance competing needs of legitimate ocean uses, protected species, and natural acoustic habitats will continue to present NOAA significant challenges over the coming decade. The recommendations outlined in the Roadmap suggest cross-agency actions that would put NOAA on the path to meeting these challenges and achieving the goals of the Strategy. It is important to note that in addition to conserving marine resources, NOAA's mandates include allowing impacts to marine species and their habitat, including impacts from noise, provided those impacts are not too severe and

[1] The sound present in a particular location and time, considered as a whole.

[2] Distinguishable soundscapes experienced by individual animals or assemblages of species, inclusive of both the sounds they create and those they hear.

appropriate protective measures are included. NOAA implements these responsibilities via authorizations, consultations, and other mechanisms, and incorporates a variety of protective measures to minimize the impacts of noise. The Strategy aims to further ensure that NOAA is addressing these broader goals as effectively as possible across multiple actions and programs, and that the agency is targeting the science and stakeholder engagement necessary to support its diverse responsibilities.

HISTORY AND DEVELOPMENT OF OVERARCHING GOALS

In 2010, NOAA leadership committed to improving the tools used by the agency to evaluate the impacts of anthropogenic noise on cetacean species. This led to the convening of two parallel data- and product-driven working groups collectively known as "CetSound" (Cetaceans and Sound Mapping). The CetSound working groups: (1) created a new cetacean density and distribution data visualization and exploration tool, and; (2) predicted wide-ranging, long-term underwater noise contributions from multiple human activities. In 2012, the geospatial tools developed by these working groups were presented to a large audience representing a diversity of stakeholders. Following the broadly positive reception of the tools, NOAA leadership encouraged the development of a 10-year Ocean Noise Strategy to guide the agency to a more integrated and comprehensive management of ocean noise impacts.

Staff and leadership from NOAA Fisheries' Offices of Protected Resources and Science and Technology and the National Ocean Service's Office of National Marine Sanctuaries identified ***four overarching goals*** the Strategy aims to achieve:

1. SCIENCE: NOAA and federal partners are filling shared critical knowledge gaps and building understanding of noise impacts over ecologically-relevant scales
2. MANAGEMENT[3]: NOAA's actions are integrated across the agency and minimizing the acute, chronic and cumulative effects of noise on marine species and their habitat
3. DECISION SUPPORT TOOLS: NOAA is developing publically available tools for assessment, planning and mitigation of noise-making activities over ecologically-relevant scales
4. OUTREACH: NOAA is educating the public on noise impacts, engaging with stakeholders & coordinating with related efforts internationally

In order to advance a 10-year strategy to accomplish this vision, in 2013 NOAA leadership solicited participation in a cross-NOAA team (see Appendix D) that would encompass a diverse group of scientific experts, regulatory practitioners, managers, and lawyers who are knowledgeable in the field of ocean noise and represent multiple programs or authorities through which NOAA regulates, researches, and has activities that create ocean noise. Participants identified the need for a roadmap document to articulate the goals of the Strategy and to suggest approaches for achieving a more integrated and comprehensive understanding and management of ocean noise impacts. A subset of participants (see Appendix D) then drafted the Ocean Noise Strategy Roadmap. The draft Roadmap was circulated in 2015 first among all Strategy participants, and then more broadly within the line offices they represented. In addition, Strategy leads provided informational briefings and distributed the document to additional NOAA programs that had potential interest in the initiative but that did not identify staff to participate in the drafting.

[3] The term "management" refers here to all NOAA actions that seek to reduce or eliminate impacts to trust resources. Such actions include a variety of methods by which individual NOAA programs implement their long-term strategic plans, including, but not limited to, activity-specific regulation of impacts to individual species, prioritization of internal capacities, providing regional, national and international leadership or coordination of protective actions, and providing recommendations or guidance to other federal and state agencies.

OCEAN NOISE STRATEGY ROADMAP

The purpose of the NOAA Ocean Noise Strategy Roadmap is to support the agency's use of its capabilities and authorities to more effectively understand and address the effects of noise on protected species *and* acoustic habitats. Four chapters address key elements of the Strategy's approach and provide place-based examples:

> **Chapter 1:** Reviewing *species level* impacts of ocean noise and associated management actions
> **Chapter 2:** Establishing the foundation for understanding and managing *acoustic habitats* for NOAA trust species and places
> **Chapter 3:** Reviewing NOAA's current capability to *characterize aquatic soundscapes* and enhancing this capacity for the future
> **Chapter 4:** Applying risk assessment to place-based examples that highlight Roadmap science and management recommendations

Chapter 1 (Reviewing *species level* impacts of ocean noise and associated management actions) with associated Appendices, summarizes the status of the science needed to understand, characterize, and manage the effects of noise across NOAA's protected species. The Chapter outlines and summarizes historical approaches to noise management, and presents recommendations for improved approaches moving forward. The Chapter highlights the current status of and need for methodological approaches to determine population level and cumulative consequences to NOAA resources. NOAA's authorities for addressing noise impacts on managed species and their identified habitats are then summarized, and current practices for applying these authorities are described. The Chapter identifies high priority science, risk assessment, and management examples to increase the effectiveness of NOAA's current management practices to address chronic and cumulative noise impacts, and broaden practices to better address impacts to turtles, fish and marine invertebrates. Additional detail is provided in the associated Appendices. Appendix A outlines the status of science regarding sound use by, and noise impacts to, four broad taxonomic groups for which NOAA has different management responsibilities: marine mammals, fish, invertebrates, and sea turtles. Appendix B summarizes the status of information regarding presence, abundance, distribution, density, habitat use, and population trends for these species.

Chapter 2 (Establishing the foundation for understanding and managing *acoustic habitats* for NOAA trust species and places) presents the basis for the development of an agency-wide strategy to more comprehensively manage noise impacts on acoustic habitats. NOAA's place-based management tools are examined to consider their application to acoustic habitat protection goals, highlighting activities that are underway or could be undertaken to achieve these goals. Recommended activities include: 1) partnerships with regulated federal agencies and industries to address longer-term and wider-ranging noise impacts via promotion of quieter technologies; 2) development of tools and application to marine planning and traditional protected species management efforts to account for cumulative noise within places where acoustically active or sensitive species live; and 3) fulfilling the current potential of existing NOAA authorities to address noise implications within areas with more holistic protective goals, such as National Marine Sanctuaries. Throughout, information needs for NOAA's identification of high risk acoustic habitats are discussed, including implications for broadening the focus of noise-related research to better characterize habitat status and noise influence as mediated through entire ecosystems.

Chapter 3 (Reviewing NOAA's current capability to *characterize aquatic soundscapes* and enhancing this capacity for the future) addresses the science needs highlighted in Chapters 1 and 2 that suggest a need for the agency to augment its capacity to effectively understand and accurately characterize

soundscapes and the component sounds that comprise it. Soundscapes can be characterized through the use of a range of both fixed and mobile equipment platforms to collect acoustic data. Acoustic analyses can include measurement of both specific sounds over short time frames, to broader quantifications of the multiple component sounds and overarching variability inherent in a soundscape or acoustic habitat. In addition, in the absence of empirical data, the use of predictive sound field modeling to assess the likely acoustic contribution of anthropogenic sources in various human-use scenarios plays a key role in meeting NOAA's science and management goals. Offices across NOAA are increasingly utilizing a variety of fixed and mobile platforms to collect acoustic data to study the ecology and behavior of marine animals, ambient ocean noise, geophysical events, as well as anthropogenic noise that could affect marine life. To support and continue this expansion in NOAA's passive acoustic research capability, the Roadmap recommends strategic coordination among research programs, development of a standardized data and metadata archival system and analysis routines, and increased predictive modeling capacity to achieve the Strategy's science and management priorities.

Chapter 4 (Applying risk assessment to place-based examples that highlight Roadmap science and management recommendations) presents two place-based case studies that highlight the Roadmap's science and management recommendations within a risk assessment process. Risk assessment can integrate information regarding soundscapes and the places and species the agency manages in order to identify priorities for noise management. Results can inform NOAA's decision-making regarding allocation of limited agency resources to address data gaps. Finally, risk assessment can support choices regarding which management approaches to apply as well as highlighting the need for enhanced authorities or partnerships, and provide mechanisms for evaluating the success or failure of various approaches. The first case study applies risk assessment processes to examine noise impacts to fin, blue and humpback whales in and around Channel Islands National Marine Sanctuary. The second case study provides a preliminary assessment of spawning areas used by acoustically sensitive and commercially important fishes off the U.S. East Coast. These case studies identify current or potential NOAA assets for assessing noise risks and managing noise impacts, highlighting partnerships that are in place or could be further developed to address Roadmap recommendations for science, management and outreach.

SUMMARY OF OVERARCHING AND CROSSCUTTING RECOMMENDATIONS

Chapters 1-3 include recommendations for steps NOAA could take to achieve the Strategy goals. A summary table of these recommendations follows, categorized by the primary Strategy goal each action addresses and the key chapter(s) in which it appears. Relevance to multiple Strategy goals is identified for some recommended actions. These recommended actions would enhance understanding and management of the species and habitats under NOAA's care and utilize the diverse expertise within the agency to more comprehensively address the impacts of noise.

Primary Strategy Goal	Recommendation	Key Chapters	Additional Goals Addressed
Management: Expanding types of, scopes of, and coordination among NOAA authorities to address noise issues		1,2	
	Identification and utilization of a full range of NOAA authorities to better manage the impacts of noise on trust resources	1,2	
	Development of national guidance for acoustic impact thresholds and other management tools	1	
	Increased use of programmatic approaches through MMPA and ESA to allow for better consideration of multiple activities, longer timeframes, and acoustic habitat impacts	1,2	
	Improving management effectiveness for acoustic habitat through incorporation of place-based authorities as they relate to species or habitat focused goals	2	
	Utilization of National Marine Sanctuaries to develop increased capacity for preserving, restoring, and maintaining natural acoustic habitats, as well as the protected species associated with them, through new management measures, regulations, dedicated scientific research, and outreach programs	2	Science; Outreach
	Expansion of existing international partnerships with regulated agencies and industries to promote use of quieter technologies	2	Science; Outreach
Science and Monitoring: Development of comprehensive and forward-looking science plans identifying most effective and efficient means to address critical data needs for understanding noise impacts on protected species and acoustic habitats		1,2,3	Management
	Establishment of a NOAA-led, long-term, standardized listening capacity across the agency	3	Management
	Development of an archival database to house NOAA passive acoustic metadata, raw data, and outputs of standardized data analysis routines	3	Tools
	Enacting monitoring requirements for compliance processes that reflect comprehensive science goals, and further identifying actions that may be taken at different scales to address varying resources and capabilities	1	Management
Decision Support Tools and Services: Development of processes and tools to compile, geospatially depict, and analyze marine species distributions, soundscapes, and NOAA-permitted/authorized activities for use in risk assessment, mitigation development and planning.		1,2,3,4	Management; Science; Outreach
	Developing NOAA 'in-house' capacity for predictive sound field and sound exposure modeling	1,3	Management; Science; Outreach
	Standardization of data analysis routines and output metrics for soundscape measurements	3	Science; Outreach
Outreach, Collaboration, and Stakeholder Engagement: Further development of outreach programs to support the activities outlined above		1,2	Management; Science; Tools