Alaska Inter-Tribal Council • Clean Ocean Action • Hands Across the Sand • Mission Blue Ocean Conservation Research • Oceana • The Ocean Foundation

Re: Ocean Noise Strategy Roadmap Critique and Recommendations

July 1, 2016

Dear Ocean Noise Strategy Roadmap authors

We commend you on your thorough synthesis of ocean noise concerns and issues in the draft "Ocean Noise Strategy Roadmap" (hereinafter "Roadmap"). It has been a matter of great anxiety that the state of regulatory oversight has been rapidly falling behind the state of practice and the advances in scientific understanding. So this document comes as a breath of air that has long been needed.

Many of the issues detailed in the document congeal the concerns that many of us have expressed over the years (and in some cases decades) of comments we've made in our critiques of the many Environmental Impacts Statements (EIS), submitted though your agency for public review. The Roadmap will be extremely helpful because it can now serve as a proxy for these concerns in future Draft EISs without our needing to continually re-substantiate these concerns through citing the originating peer reviewed literature.

This is a significant step in the right direction, albeit while the Roadmap has embodied many of the ideas that have been in the conversation for years, these ideas expressed in the Roadmap are still not reflected in the current regulations. While there is no scheduled "action plan" in the Roadmap, we are encouraged that already one program mentioned in the document[1], the "Ocean Noise Reference Station Network' (NRS) is being implemented."[2] This program will no doubt allow for empirical data to be referenced in the NOAA CetSound/SoundMap program where currently data is derived predominantly from "Predictive Sound Field Mapping" rudimentary propagation models and shipping and seismic survey data.[3] We anticipate data from the NRS program to be extremely helpful in calibrating some of the assumptions made in the SoundMap program, although we recommend that the bandwidth of the system be expanded to include periodic snapshots of frequencies up to 100kHz to record new high frequency communication and data systems increasingly being deployed in the ocean. (This will be expanded upon below).

We are also encouraged that the Roadmap includes the terms "soundscapes" and "acoustic habitats" acknowledging the context of systematic impacts due to cumulative exposures and concurrent and multiple exposures from different noise-sources. While the metrics of these considerations are much more complex than summing up the particular impacts of specific exposures on estimated marine mammal populations, it acknowledges what we all know to be

[1] Roadmap "Future Directions: Establishment of NOAA-led, long-term, standardized passive acoustic research capacity across the agency" P 57
[2] Sound Check: New NOAA Effort Underway to Monitor Underwater Sound." Currently (6/16) at https://www.st.nmfs.noaa.gov/feature-news/acoustics "
[3] Roadmap "Predictive Sound Field Mapping" p. 50

true; that the environment is a complex fabric of ecosystems and not just a sum of individual exposure targets living in regional volumes of seawater.

The inclusion of the terms "soundscape" and "acoustics habitat" also opens up pathways for the critical evaluation of marine habitats over longer timeframes (where there are existing baseline metrics) and the consideration of developing chronic noise exposure impacts where baselines do not exist. Increasingly these chronic exposures include more than increases in shipping traffic due to coastal and port development; these chronic exposures are beginning to include a proliferation of continuous noise due to the industrialization of the outer continental shelf and high seas.

These proliferating noise sources include offshore energy industry installations such as seafloor oil and gas processing equipment, thruster-stabilized production platforms for minerals and hydrocarbon extraction, windfarms, tidal energy harvesting, military training ranges, offshore aquaculture operations, seafloor and buoy mounted acoustical navigation beacons, current profilers and marine altimeters, and multi-nodal communication networks for wide-area autonomous underwater vessel control and communication.

With the exception of a cursory mention of a few of these chronic sources in the Executive Summary (wind farms) and Chapter 1 (wind, wave, and tidal energy "farms," and acoustic deterrents) and a few references to cooperation with the US Navy in the Atlantic Fleet Testing and Training (AFTT) ranges in the Roadmap[4] none of these expanding chronic noise sources are specifically addressed in the document. This is troubling because it again raises our concern that the agency is not up to speed on the current state of marine energy and extractive industries.

The Roadmap does brings up – for the first time in NOAA literature, the fact that heretofore the agency has focused on catastrophic and easily quantifiable and noticeable impacts of noise on marine life and has underemphasized more subtle and nuanced effects of noise on marine habitat. We hope that the statements that "more science is needed to characterize variation in the production or perception of intraspecific communication signals in natural areas with different background noise conditions" and "more science is needed to better document the quietest signals that animals can (and do) perceive in the wild[5]" become actual commitments to fund this research.

Under the rubric of "Consistent Messaging, Internal Education, and Coordination" the document suggests that "all NOAA offices should, ideally, be using the same terminology and concepts to describe the issues surrounding aquatic noise impacts on species and acoustic habitat." We support this and suggest that the comment be referenced to consistent national and international standards under ANSI/ASA 3.20 "Bioacoustics terminology," and ISO 18405 "Underwater Acoustics – Terminology" (forthcoming).

[4] Roadmap "Characterization of Human Introduced Sounds" p.9
[5] Roadmap "NOAA's Tools for Acoustic Habitat Risk Assessment" p.31

Recommendations:

Prioritize issues of concern

The Roadmap is layered with actions and concepts: from philosophical frameworks to public engagement. But the efficiency and effectiveness of using the roadmap will be dependent on prioritizing identified actions and sketching out action plans. Some elements of this are obvious; gathering acoustical baselines marine acoustical habitat could not happen soon enough, on the other hand coordinating with intersecting agency jurisdictions to define and collaborate on desired outcomes will likely be driven by other factors such as the National Ocean Policy Act and the priorities of the various coordinating agencies. (The "Spreadsheet of Potential Authorities" in Appendix C alludes to the complexity of this task.)

Adopt standard terminology

Terminology used in internal, interagency, and public communications should conform to ANSI/ASA 3.20 "Bioacoustics terminology," and ISO 18405 "Underwater Acoustics – Terminology" standards.

Develop funding strategies for issues of concern

NOAA should provide or coordinate funding for more nuanced studies on impacts of chronic noise on marine habitats and more nuanced studies of marine animal perception – particularly fish and marine invertebrates.

Increase bandwidth for noise monitoring of marine habitats up to 100kHz

Increasingly digital and autonomous control technologies are being introduced into the ocean that are designed to operate in the 10kHz-100kHz range (see Fig. 1). These are used for navigation, platform positioning, sea state monitoring, control of autonomous research and industrial vessels, underwater multi-nodal communication networks, current profiling, and sea-surface altimeters. It is not uncommon for these individual pieces of equipment to operate at source levels in excess of 200dB (re: 1µPa). Most of these systems operate in arrays, adding to the din and colonizing large areas that would otherwise be habitat.

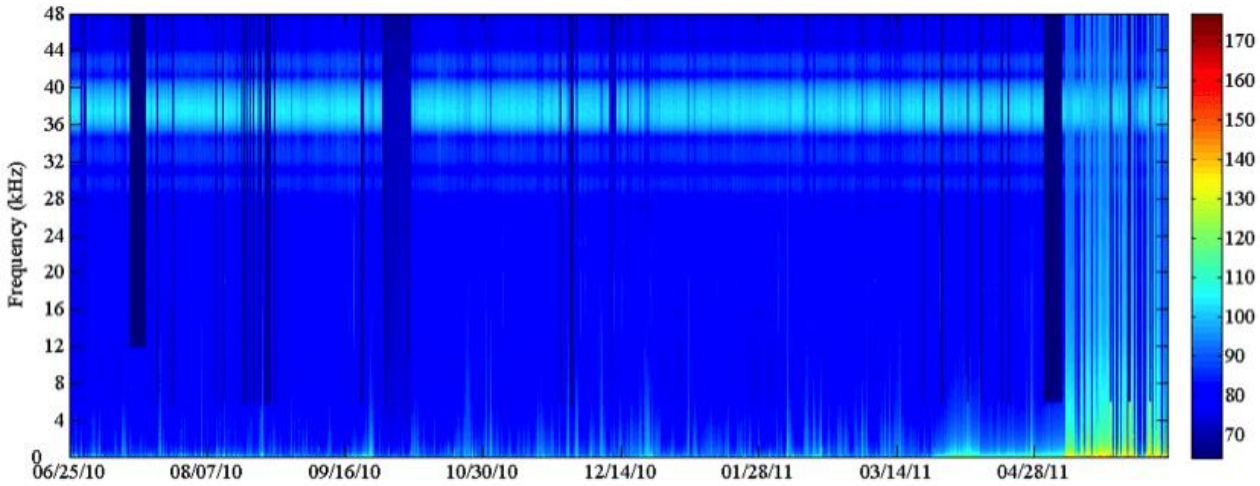

Fig 1. A year-long spectrogram capturing what appears to be a multi-frequency or spread-spectrum signal between 36kHz and 40kHz (Neptune Canada)

Operating noise monitoring equipment at broad bandwidths is data and memory intensive, but due to the continuous nature of many of these signals the scope of the problem can be assessed by way of brief and occasional high-sample-rate "snapshots" throughout any given monitoring regime.

Make ocean noise data readily available to the public

Encourage publication of marine sound recordings gathered through academic and industry research to make these data publicly available. This may be as easy as expanding the NOAA CetMap/SoundMap program or archived and accessible through the National Centers for Environmental Information to provide access to sound recordings and live data.

Make archived data accessible by way of a data/metadata and spatial-temporal database archival and retrieval system such as Tethys[6].

Support ongoing efforts for detection and classification of various noise sources in large datasets.

This proposal dovetails into the proposal to provide easy access to recordings and live audio feeds.

Support broader research into impacts related to sound quality and signal characteristics.

Sound and noise characteristic mentioned in the Roadmap refer only to soundscape or habitat characteristics. Signal characteristics are also a significant driver in animal response to sounds.

[6] See Roadmap text box under NOAA Data Holdings p.54

In many cases the quality of sound may be a more important aggravator than amplitude[7]. A metric is needed to express noise characteristics and associate sound qualities to avoidance[8].

Expand studies in noise impacts on fish and sustainability of fisheries.

After many decades of studying fish we may actually know much less than what the published papers would indicate about fish hearing. This is in part due to the recent understanding that many of the hearing threshold studies were performed in tanks and test environments that interacted unpredictably with the testing signals.[9] Most auditory threshold testing on fish are pressure-dependent whereas particle motion (which is also an important sound perception in many fish species) has been largely left out of the regulatory thresholds and may be as or more important to some fish species' sound detection than pressure gradient acoustical energy.[10]

There also seems to be an enduring tenacity of the idea that fish are not subject to permanent hearing damage because of hair-cell regeneration. This assumption is substantiated by way of two papers, Lombarte et al. (1993),[11] Smith et al. (2003)[12]. We feel that the assumption that fish do not suffer permanent hearing damage is a weighty assumption to hold its footing based on just two papers. In Lombarte et al the hair cells were chemically damaged (with gentamicin) which may not be an adequate analogy for hair cell damage due to physical force, and Smith study was on Goldfish, which is not an adequate proxy for 30,000 other fish species that are not fresh, shallow, turbid water dwellers.

Over the course of 25 years no other published studies have a) confirmed hair cell restoration and b) examined hair cell loss (and regeneration) across a wider variety of species. Much more needs to be known about fish hearing – from the extreme exposure causing physical damage to the more subtle impacts and effects of various types and proximities of noise on fish and fish populations.

Expand studies of noise impacts on marine invertebrates and habitat interactions.

Many marine invertebrates inhabit marine interface areas that provide habitat or habitat services for the entire trophic pyramid. Coral reefs are one clear example, and while some studies have been done on reef species recruitment dependency on sound perception,[13] more data are needed on sound and noise impacts on reef systems. One recent study on noise impacts of invertebrates that mediate substrate properties, compromising the fluid and particle transport provided by these

[7] Ronald A. Kastelein, Willem C. Verboom, Nancy Jennings, Dick de Haan (2008) "Behavioral avoidance threshold level of a harbor porpoise (*Phocoena phocoena*) for a continuous 50 kHz pure tone" J. Acoust. Soc. Am. 123:4
[8] M. Stocker, T. Reuterdahl, L. Horne, G. Hurley (2007) "A simple ocean noise exposure metric based on naturally occurring noise levels and biological thresholds" J. Acoust. Soc. Am. V 122:5
[9] Art Popper – personal communication
[10] Anthony D. Hawkins , Ann E. Pembroke, Arthur N. Popper (2014) "Information gaps in understanding the effects of noise on fishes and invertebrates" Rev Fish Biol. Fisheries DOI 10.1007/s11160-014-9369-3
[11] Lombarte, A., H.Y. Yan, A.N. Popper, J.C. Chang, and C. Platt. (1993). "Damage and regeneration of hair cell ciliary bundles in a fish ear following treatment with gentamicin." Hearing Research 66: 166-174
[12] Smith, M.E., A.S. Kane, and A.N. Popper. (2004). Noise-induced stress response and hearing loss in goldfish (Carassius auratus). J. Exp. Biol. 207:427-435
[13] Vermeij MJA, Marhaver KL, Huijbers CM, Nagelkerken I, Simpson SD (2010) Coral Larvae Move toward Reef Sounds. PLoS ONE 5(5): e10660. doi:10.1371/journal.pone.0010660

invertebrates that "fluff up" the benthic sediment. This has an alarming implication for the possibility that large areas exposed to noise (from shipping or wind farms for example) may become impacted and compressed and thus less suitable as marine habitat[14] starting at the bottom of the food chain.

Evaluate the entire soundscape of any proposed anthropogenic noise activities

Increasingly proposed activities are complicated by concurrent technologies all producing their own specific sounds. Some examples are 2D and 3D seismic surveys utilizing bottom profilers; 4D seismic surveys utilizing acoustically controlled AUVs that pluck and place bottom-mounted seismometers (oriented by way of stationary acoustical navigation beacons); seafloor extraction processing operations with high-pressure equipment, acoustical communications, thruster-stabilized (and acoustically oriented) operating platforms, and ongoing lighters and tankers loading and offloading product and supplies. These are all very complex environments and create very complex sound fields.

Current regulations only provide for evaluating individual processes or pieces of equipment. These legacy regulatory guidelines have proven to be even less than rudimentary given the complexities of the acoustical habitats and our expanding understanding of metabolic and course-grained (long term) behavioral impacts of sound on marine life.

The roadmap includes the ideas of "broader quantifications of the multiple component sounds" and the "overarching variability inherent in a soundscape or acoustic habitat." When evaluating a proposed activity, the entire compliment of added noise needs to be considered and the evaluation process should employ engineering or operations personnel conversant in the entire operation chain to build up a dynamic and complete acoustical representation of the proposed activity. This then should be used as the exposure impact model.

Invoke the Precautionary Principle in all deliberations on introducing anthropogenic noise

As our understanding of the impacts of noise on marine habitat has become more acute we are finding that many of our concerns expressed over the years that were not heeded turned out to be correct. We find that as we become more technologically capable of modeling and understanding biological relationships to sound and noises that the entire bioacoustic field is much more subtle and nuanced than expected. Had we used the Precautionary Principle[15] from the beginning of our concerns we would not be finding out about many noise impacts "the hard way." As we preside over the industrialization and militarization of the ocean we should do so under the rubric of precaution.

Overall we deeply appreciate the systems framing of the Roadmap; the inclusion and consideration of "non-protected" marine taxa; the call for the consideration of impacts from

[14] Martin Solan, Chris Hauton, Jasmin A. Godbold, Christina L. Wood, Timothy G. Leighton & Paul White (2016) "Anthropogenic sources of underwater sound can modify how sediment-dwelling invertebrates mediate ecosystem properties" Nature: Scientific Reports 6:20540 |DOI: 10.1038/srep20540

[15] Raffensperger, Jackson, Tickner (1999). Protecting Public Health and the Environment: Implementing The Precautionary Principle, Island Press

cumulative, multiple, and concurrent noise exposures; the consideration of impacts of "below threshold" chronic noise sources; greater understanding of how to asses population-level impacts, consideration of synergistic impacts of noise with other stressors; and the acknowledgement that more data are needed - particularly in terms of noise impacts on fishes and marine invertebrates.

It is also encouraging that interagency cooperation is elicited. While interagency coordination is indicated in the National Ocean Policy[16] it will take the efforts of all agencies to build the bridges of cooperation.

The Roadmap seems quite ambitious and will need much public support. The draft document represents a quantum improvement over the regulatory guidelines that have dominated agency conservation efforts to date. But it is a roadmap and not an action plan – and a roadmap serves a limited utility if left in the glovebox. We endorse the document and hope that our recommendations will inform the final draft and an action plan – at which point we will gladly apply our efforts to stand behind it and bring the public on board.

Sincerely,

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[16] National Ocean Council (2013) "National Ocean Policy Implementation Plan" and "Interagency Task Force Recommendations"