

Sub-theme 1. The need for Observing System.
Sub-theme 2. Implementing and Optimizing a Pan-Arctic Observing System

MONITORING THE ARCTIC ACOUSTIC ENVIRONMENTS

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Abstract—Marine ecosystems are increasingly affected by underwater sounds. Growing scientific and societal concerns have led to several international initiatives to measure the environmental impact of ocean noise at a variety of spatial and temporal scales. The following statements are formulated around the terms of reference of the International Quiet Ocean Experiment (IQOE) for its working group on Arctic Acoustic Environments. It addresses knowledge gaps in long-term trends in soundscape characteristics, research priorities (transnational programs, equipment/infrastructure sharing), and other issues such as long-term data archiving and data access policies.

INTRODUCTION

The northern high-latitude regions, including the Arctic Ocean, are becoming increasingly important as a result of global warming and their growing economic and political interests. Sea ice reduction is facilitating resource exploration, marine transport and other economic activities in the regions. Warming waters lead to shifts in marine ecosystems and in soundscapes.

Exploitation of resources in the Arctic is expected to grow in the coming decades, offering new opportunities for marine and maritime industries. For example, the Barents Sea is the most important fishery area in Europe, and because of global warming there is a large potential for increased exploitation of living marine resources in the Arctic seas. Other regions, including the Northern Sea Route, will see increasing shipping, in particular from the Chinese One Belt One Road Initiative, and Russia aims to open the Bering Strait for large tankers. Due to the expected increase in exploitation of the Arctic marine resources, it is expected that ambient noise levels will increase in the Arctic in the coming years.

ACOUSTIC POLLUTION OF THE ARCTIC OCEAN AND SEAS

Ambient noise in the ocean is recognized as a pressing environmental and societal concern; the European Union uses it as one of its key descriptors of Good Environmental Status, as defined in the 2014 Marine Strategy Framework Directive ([http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010D0477\(01\)&from=EN](http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010D0477(01)&from=EN)). Shipping levels have already increased ambient noise underwater by 12 dB relative to 1960s levels in other parts of the world (e.g., Hildebrand, 2009), and similar effects can be expected in the Arctic region (e.g. Blondel et al., 2015). Other sources of human-generated sounds already include seismic exploration, either for delineation of Exclusive Economic Zones or for resource mapping (e.g.,

Geyer et al. 2016; Blackwell et al., 2015). These sounds, observed at frequencies of 10–200 Hz, can be detected as far as 1,400 km from the actual surveys, and are predicted to become louder as the Arctic Ocean warms up. Increased tourism, from large vessels and small craft, will increase sound levels both at lower frequencies (e.g., the 63 Hz and 125 Hz used by the European Marine Strategy Framework Directive for assessing noise pollution from shipping (MSFD, 2014)) and at higher frequencies, particularly in coastal waters (e.g., Stafford, 2013). Resource extraction, with drilling and large offshore structures, will contribute to the ambient noise. Increased naval activity by neighbouring countries might also add to the general acoustic budget. Evidence-based monitoring and management of the Arctic environments requires a diversity of baseline measurements of different acoustic metrics, for noise pollution and as proxies for other processes, and a good physical grounding of current and expected changes.

INTERNATIONAL COLLABORATIONS AND IQOE

Several actors, academic, governmental and commercial, are already collecting passive acoustic data in the many marine environments making the Arctic region, but the different activities are not coordinated and communication is not very developed. It is therefore imperative to increase collaboration in the Arctic in order to obtain a better knowledge of current noise status and more coordinated observing programs in this harsh environment. This is the goal of the International Quiet Ocean Experiment (<http://iqoe.org/>), which has established a working group on the Arctic Acoustic Environment. This working group aims to produce an acoustic baseline against which future sound increases can be compared. There is a lack of consistent data management and data-access policies for scientists and data centers in the field of passive acoustics, and IQOE has established a working group to improve collaboration within this field. Furthermore, standardization of experimental protocols and observational techniques, and calibration of instrumentation (such as acoustic recorders) are essential to enable comparison of results. Another IQOE working group will aim to recommend best practices for experiments, observation, reporting, and other means to ensure that results are comparable and can be integrated to standardize data across large spatial and long-time scales.

FINAL STATEMENT

The IQOE Working Group on “Arctic Acoustic Environments” hopes to get the approval and support from AOS 2018 for its work on conducting the following activities:

- Identify locations of existing acoustic receivers in the Arctic Ocean
- Identify potential sources of historic acoustic data from the Arctic Ocean
- Inform the IQOE Data Management and Standardization working groups of historic and current data sources in the Arctic Ocean
- Compile existing acoustic data to determine whether time series showing evolution and future trends of relevant acoustic metrics can be created and report to Data Management and Data Access WGs
- Create a synthesis of research papers and state-of-the-art knowledge on the effects of sound on organisms in the Arctic Ocean
- Identify data/research conducted on the effects of permafrost and gas-saturated sediments on Arctic Ocean soundscapes
- Identify an ideal receiver array (location, number of receivers, types of receivers) to observe the baseline acoustic environment for the Arctic Ocean
- Identify ongoing going and planned experiments for which passive acoustics are planned or could be added
- Conduct/Support endorsement processes for passive acoustic projects with the Arctic Council

REFERENCES

Blackwell, S.B., C.S. Nations, T.L. McDonald, A.M. Thode, D. Mathias, K.H. Kim, C.R. Jr. Greene, A.M. Macrander, “Effects of Airgun Sounds on Bowhead Whale Calling Rates: Evidence for Two Behavioral Thresholds”, *PLOS One*, 10(6):e0125720, doi: 10.1371/journal.pone.0125720, 2015

Blondel, P., Sagen, H., Martin, B., Pettit, E.C., Tegowski, J., Thodes, A., Tollefsen, D. and Worcester, P.; “Report of the Polar Session, Oceanoise2015”, Vilanova i la Geltrú, Barcelona, Spain, 10-15 May. (Editors Michel André & Peter Sigray), http://oceanoise2015.com/?page_id=789, 2015

Geyer, F., Sagen, H., Hope, G., Babiker, M., Worcester, P. F., Identification a quantification of soundscape components in the Marginal Ice Zone, *Journal of Acoustical Society of America* 139, 4, 2016

Hildebrand, J. A., Anthropogenic and natural sources of ambient noise in the ocean, *Marine Ecology Progress Series*, 395, 5-20, 2009

Stafford, K., “Anthropogenic sound and marine mammals in the Arctic: increases in man-made noises pose new challenges”, The Pew Charitable Trust, 20 pp., <http://ww.oceansnorth.us>, 2013