UN-Maritime Acoustic Environment

CONSORTIUM FOR Ocean Leadership

Workshop toward Planning an Ocean Sound Decade

SUMMARY REPORT
April 29, 2022

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Executive Summary and Key Findings

The ocean soundscape consists of both natural and anthropogenic inputs of sound and varies over time and space. Understanding this soundscape is important for managing healthy ocean ecosystems that support many benefits for society. Additionally, ocean sound is an important tool for scientific study and observation, with passive acoustic monitoring offering a noninvasive approach to scientific study and monitoring of ocean ecosystems and fisheries.

The UN Decade of Ocean Science for Sustainable Development (UN Ocean Decade) endorsed programme on the Maritime Acoustic Environment (UN-MAE) is focused on building a community that has the tools and knowledge to inform a variety of research, policy, and management uses related to and supported by underwater ocean sound information. The programme's goals include increased representation and inclusion of ocean sound and acoustics in ocean observing and in support of the sustainable blue economy, an ocean sound literate public, a raised awareness of educational and workforce opportunities in ocean sound and acoustic science, and an improved global capacity for measuring, understanding, predicting, and managing the ocean soundscape.

The Consortium for Ocean Leadership (COL), with support from the Richard Lounsbery Foundation, coordinated a full-day hybrid-format workshop on April 29, 2022 to convene members of the ocean sound and acoustics community around the goals of the UN-MAE. The workshop focused on ways the ocean sound and acoustics community can engage with the opportunity allotted through the UN Ocean Decade and the UN-MAE endorsed programme to advance the field and contribute to understanding and management of the ocean. It was a starting point in building collaboration by leveraging activities and contributions across the ocean sound community and the UN-MAE programme to support common goals. The workshop focused on identifying outreach and partnership strategies to advance ocean literacy and increasing data and technology capacity.

A key theme across all of the discussions was the issue of communicating the value of ocean sound information and understanding. The ocean sound community tends to be limited by its use of highly technical terminology and needs to seek partners to help with outreach and communications efforts that can translate technical information to general audiences. Potential partners for this were identified and strategies to engage with them should be developed.

An exciting new partnership commitment arose as a result of the discussions around data archiving and access. A partnership between Amazon Web Services and Spear AI will develop a repository of acoustic data that will allow researchers and industry partners to access data in a user-friendly cloud-native manner. This is truly a step forward for the ocean sound community and has potential to grow into additional applications.

The workshop participants recognized the value of a forum for ongoing discussions. UN-MAE offers an avenue for ongoing discussions as an endorsed UN Ocean Decade programme under which the ocean sound and acoustics community can submit projects, activities, and contributions. As with all UN Ocean Decade programmes, some capacity for managing coordination, collaboration, and dialogue across affiliated groups around the world is needed as it is not supported directly by the UN Ocean Decade infrastructure and framework. This capacity to bring the ocean sound community together will be necessary to build momentum and to realize the actions and ideas from this workshop, as well as the goals of the UN-MAE and UN Ocean Decade.

Introduction

The Consortium for Ocean Leadership (COL), with support from the Richard Lounsbery Foundation, coordinated a full-day hybrid-format workshop on April 29, 2022 to convene members of the ocean sound and acoustics community around the goals of the UN Decade of Ocean Science for Sustainable Development (UN Ocean Decade) endorsed programme on the Maritime Acoustic Environment (UN-MAE). UN-MAE's goals are broadly focused on building a community that has the tools and knowledge to inform a variety of research, policy, and management uses related to and supported by underwater ocean sound information. The programme's objectives include:

- increasing the representation and inclusion of ocean sound and acoustics in discussions and groups related to ocean observing and the sustainable blue economy,
- building literacy and education for ocean sound and acoustic science, and
- improving global capacity as a community to measure, understand, predict, and manage the ocean soundscape.

Human activity in the ocean—from recreational to commercial to military—generates sound. Marine organisms utilize sound for a variety of life strategies, such as communication, predation and prey avoidance, and reproduction, and many species have evolved to take advantage of their natural soundscape. Scientific evidence indicates that anthropogenic sound in the ocean has adverse effects on marine life from marine mammals to invertebrates. Human use of the ocean will continue to grow and so an understanding of the ocean soundscape, both natural and anthropogenic, is important for managing healthy ocean ecosystems that support many benefits for society. But ocean sound is not only an input to the ocean, it can itself be an unintrusive (i.e., passive) tool for scientific study and monitoring of ocean ecosystems and fisheries. Taking advantage of and applying the use of ocean sound as a systematic tool for ocean observing will require technology development, data management and access strategies, and growth in education and technical talent in ocean acoustics.

This workshop focused on ways the ocean sound and acoustics community can engage with the opportunity allotted through the UN Ocean Decade and the UN-MAE endorsed programme to advance the field and contribute to understanding and management of the ocean. The workshop also discussed opportunities for support of UN-MAE activities and goals in the form of funding, other resources (e.g., technology), in-kind support, and partnerships.

The workshop brought together 18 different organizations from the United States and Canada, from federal and state/provincial government, academia, industry, and philanthropy with varying roles and potential roles (e.g., data collection, users and stakeholders, funders) in the ocean sound community. Stakeholder interests in sound data included:

- Ecosystem management (e.g., monitoring sound, stressors, and the impacts of ocean sound);
- Shipping and transport;
- Fisheries;

- Endangered species;
- Conservation;
- General oceanographic research; and
- Public outreach.

Participants represented federal agencies, academic research programs, industries engaged in acoustic monitoring, research, and technology, an international non-governmental organization for ocean research, and philanthropic organizations that conduct and support oceanographic and acoustic research. Representative programs from outside of North America were invited but were unable to participate.

The workshop was an initial step in establishing collaborative ideas and actions across the global ocean sound community in the areas of building ocean sound literacy and partnerships for capacity building and outreach. The ocean sound literacy discussion centered on the development of "soundbites" or short, catchy taglines that could form the basis of outreach and engagement campaigns that would resonate with audiences (e.g., public, students, innovators, future workforce, researchers). The partnership discussion identified new collaborations to advance the goals of UN-MAE, the global ocean sound community, and the UN Ocean Decade in terms of public engagement, data collection and technology, and data archiving and access.

Building Ocean Sound Literacy: Soundbites

During the first working session, workshop participants opened discussions on how the ocean sound community can leverage the tools and knowledge to inform policy and management through pinpointing key priorities. Four themed breakout groups were formed to brainstorm compelling slogans, or soundbites, for different ocean sound use cases. The themes were: 1) outreach for awareness, excitement, and value of ocean sound, 2) in support of best practices and environmental stewardship, and 3) targeting education and exciting career opportunities. Each breakout group discussions established their audience, highlighted barriers in previous communication efforts, and developed soundbites to connect and engage the public in the ocean sound community. A summary of the most popular soundbites from each breakout group are as follows:

> For outreach to build awareness, excitement, and understanding of the value of ocean sound:
>
> - "The ocean is one of the world's greatest symphonies. Listen to the concert"
> - "Pioneer the new sensory world of ocean sound"
>
> In support of best practices and environmental stewardship:
>
> - "Birds have a dawn chorus – did you know fish do too?"
> - "Discover the deep and hidden world of the ocean through sound"
> - "A healthy ocean is a sanctuary of sound"
> - "Listen to the ocean's heartbeat, hear the pulse"
> - "Keep the ocean orchestra in the key of sea (C)"

Targeting education and exciting career opportunities:

- “Listen to the solutions whispered by the ocean”
- “Soundtrek: the new ocean frontier”

The discussion also centered on the current barriers to sharing messages about ocean sound with various global communities. For example, the soundbites needed to be inclusive of economic class and geography, and therefore, language diversity, which must carefully consider hearing impaired and accessibility, and translate well across languages. Before putting the above soundsbites into use, they should be translated into the five most common world languages: English, Spanish, Mandarin, Hindi, and French.

A communication plan was discussed for sharing the soundbites effectively. This communications plan would establish communication channels and platforms, project roles and key stakeholders, a target audience, clear goals, a detailed messaging strategy, and incorporate feedback from identified stakeholders and the public. During this discussion, participants highlighted the need to gain a better understanding of the general public’s knowledge about ocean sound and its importance. If identified, those key understandings should be incorporated into the communications plan to better target the identified audience and improve outreach on ocean sound. Additionally, the ocean sound community needs to better communicate the challenges they aim to solve and how those challenges directly relate to people’s livelihoods. Overall, the UN-MAE’s progreamme’s communication plan should clearly state its audience, identify goals and data needed, and the application of the data in order to reach its goals. These soundbites can be used as a communication and outreach tool to progress conversations and basic knowledge about ocean sound, such as in information materials and campaigns that engage the general public to teach about sound in the ocean. Once primary soundbites are identified, feedback will be solicited from the underwater sound community at the Effects of Noise on Aquatic Life Conference in July 2022. Chosen soundbites could be launched on July 18th, World Listening Day, with a theme this year of Listening Across Boundaries.

Partnerships

The afternoon focused on forming productive partnerships for short-term and long-term projects in support of the UN-MAE programme’s goals and objectives. While many of the workshop participants are engaged in activities that can be leveraged toward the goals of UN-MAE, continued discussions will be required in an open forum to allow for ongoing engagement between participants and others in the community. Breakout groups focused on identifying potential (and new/novel) partnerships to advance technology and platforms for collecting ocean acoustic data, increasing access to ocean sound data and information, and outreach and education (i.e., ocean sound literacy).

Partnerships are needed to all facets of studying sound in the ocean, such as to:

- advance and promote best practices for archiving and curating data
- standardize data collection (e.g, requirements, formats, metadata) to enable interoperability across platforms and technologies, geography, and time

- develop and proliferate innovative technology, and
- improve ocean sound literacy.

Technology and Platforms Breakout Group - Summary of Discussion

The term partnership inherently implies that each entity engaged has something to give and something to gain from the collaborative activity. The workshop discussion recognized that it can be difficult to disentangle a partnership from a traditional client-customer relationship where a benefit or cost is exchanged, yet partnerships across organizations (and sectors) is often the only way to solve large problems, that are larger than a single client or funder (e.g., government agency) can support on its own. Partnership across sponsors and funders is critical to collect and analyze data to understand and manage ecosystems and species that serve and benefit multiple users and mission areas. Unfortunately, the funding and/or execution mechanisms are often not in place to establish efficient and effective partnerships. Workshop participants discussed some examples of successful partnerships and others that could be improved upon.

For example, underwater noise resulting from international shipping, in particular vessel traffic could create a large dataset that requires multiple partners to analyze for ocean sound effects. As international shipping and the use of the ocean continues to grow, cross sector partnerships will be critical for solutions for gathering and analyzing data. The Automatic Identification System (AIS) data from commercial ships is difficult to collect and access, which has been a limiting factor in using the data in noise and impact studies, yet if in order to model how loud the ocean was over time and space (e.g., a few kilometer grid), AIS data is needed. However, accessing and the sharing of data that could aid in studying the ocean soundscape remains a challenge. Workshop participants suggested that engaging with the International Maritime Organization (IMO) on how to best access AIS data could be productive. Saildrone outfits its platforms with AIS receivers, enabling data collection where they are operating, often in remote locations, yet the challenge remains in collecting data on ocean sound where platforms are not present. While satellite data is helpful, the cost is prohibitive for global scale monitoring. There was also discussion amongst participants on efforts to capture ocean vessels without the use of AIS to avoid some of the challenges identified, which can be a significant contributor to coastal ocean soundscapes.

Workshop participants also noted, when discussing partnerships, that good communication is often a barrier in building successful partnerships for ocean sound monitoring and research, and that the use of highly technical language can be a barrier in communicating the goals of a partnership. Partnerships and support may come more easily when the ocean sound community improves how it frames big questions and ideal outcomes, using less technical language and more approachable terminology. Challenges that simply require funding versus other needs and support should also be clearly articulated. Workshop participants asked themselves whether there was a “tool of the future” that would enable a feasible large-scale integrated network of observation. An example of this would be the Ocean Stethoscope or a website that would allow real time listening of different ocean regions and serve as a coordination hub of international ocean sound live streams all in one place. Such tools should be identified by the UN-MAE

programme in a way that government agencies, private foundations, or other funders can support the innovation and push it to scale.

Data Access Breakout Group - Summary of Discussion

The ocean sound community faces the challenge of the absence of a destination repository that allows access to ocean sound/acoustic data, enables integration and processing of existing data, and curates and archives the massive amounts of new data. This problem is challenging on a regional level where datasets remain smaller yet access to data is just as important for gaining insight into a specific ocean area, and even more so when scaling to global, which is the scope of the UN Ocean Decade and UN-MAE. It is a problem of funding and storage capacity of data (both on the regional and international scale) that the ocean acoustics community has not yet figured out but would need to overcome in order to meet these global goals. Processed data was identified as the preferable way to store and archive acoustic data because it requires less storage capacity than the raw data. However, participants noted identifying one central repository to archive and allow access to all marine acoustic data is unlikely to gain in popularity. Some repositories that already house ocean data are The Ocean Portal to Underwater Soundscapes (OPUS) and the National Centers for Environmental Information (NCEI), yet challenges remain on wider adaptation and establishing standards that all ocean users abide by. Additionally, NCEI would need improved infrastructure to support a large collection of passive acoustic data. A recommendation of the participants was for the UN-MAE programme to adapt OPUS and MANTA as key tools for those making ocean sound recordings for contribution to a global repository of standardized data products.

The participants discussed the challenge of serving dense acoustic data on cloud computing services (e.g., Amazon Web Services) and having data work efficiently with available processing, analysis and visualization tools also based in the cloud. Many data archives such as NCEI, don't have the capacity (including personnel, compute power, etc.) to solve this challenge, which makes this challenge ideal for partnering with industry or other sectors. Participants also noted that a thorough inventory of where acoustic data is stored around the globe is an important piece of building a global picture of ocean sound data.

Utilizing cloud services for passive acoustic data will also require agreed-upon architectures and data formats to enable efficient discovery of data from different sensors and programs. It was noted that the ADEON project has been addressing this issue, and there has recently been a lot of work internationally on standards and best practices for data collection and processing. Promoting these best practices is important; the UN-MAE could regularly disseminate statements on the newly published and endorsed best practices. Additionally, the U.S.- based National Institute of Standards and Technology (NIST), or internationally, the International Standards Organization (ISO) or Ocean Best Practices System (OBPS) could be an ideal owner of standards and best practices for ocean acoustic data. It was noted that NIST is not currently part of the U.S. Interagency Working Group that has put forward and leads UN-MAE. The Discovery of Sound in the Sea (website) is another potential place to disseminate this kind of information but is not an "authority" so an individual or group would need to be identified to vet such information.

Following the workshop, an exciting development was announced that resulted from this breakout discussion involving a commitment of partnership from Amazon and Spear AI, brokered by John McGunnigle of Saildrone. Spear AI will centralize, store, and curate publicly available datasets that contain acoustic data generated from academic institutions and industry partners. Partnering with Amazon Web Services, Spear AI will provide this at no cost to the user community for a period of one year. The goal is to create a central repository of acoustic data that will allow users to access the data in a user-friendly cloud-native manner. Specifically, Spear AI will provide cataloging and archiving of the data and provide guidance on how to access and make use of the data in the cloud. There is tremendous potential to grow this initial pilot into larger efforts, including building Application Programming Interfaces (APIs) that will allow broader access to the data, introducing academic institutions and organizations to large amounts of compute power, and providing a highly detailed global catalog of acoustic data collected from the world ocean.

Education and Outreach Breakout Group - Summary of Discussion

This breakout group focused on ideas for new and novel partnerships with the outreach, education, and media communities that will be effective at reaching broad public audiences. They discussed that the goal of broad education and outreach efforts should be to reach the general population, whether focusing on a regional, national, or international scale. The general public is not uniform in how it accesses information, so different approaches are needed to reach different audiences.

A set of potential partnerships was identified:

- *Aquariums*: Aquariums reach millions of visitors each year and many, due the pandemic, built robust online programming. Aquariums could place live-streaming hydrophones in their exhibits to help the general public learn about ocean sound. They can also utilize the workshop-defined soundbites in their outreach materials.
- *Scholastic News*: This publication serves educational and science content and reaches elementary (K-5/6) students around the world. Incorporating ocean sound information and lessons into the content would reach a very young audience. CNN 10 is another option, a digital news service, also available to classrooms.
- *Tiktok*: Develop Tiktok—style videos and identify content producers to share the videos to reach teens and young adults, as well as the general public. A Tiktok video competition was also suggested as a way to build grassroots content and engagement, with UN-MAE developing the judging criteria.
- *National Ocean Sciences Bowl* (www.nosb.org): This United States high school competition could have ocean sound as a theme one year and/or a regular category of questions/content.
- *Sea Grant programs*: The state Sea Grants support K-12 curriculum development and could be a partner for disseminating classroom materials and content on ocean sound. Sea Grant programs could also support graduate student research on how to best promote and communicate ocean sound information to a youth audience (e.g., ages 8-15).

- *Jeopardy*: Would Jeopardy be open to a regularly featured (or recurring) ocean sound category, which could incorporate audio clips? Jeopardy would reach an older audience. It was noted this could be a partnership opportunity broadly for ocean science and the UN Ocean Decade.
- *Philanthropies*: Partner with philanthropic organizations (e.g., OceanX, Schmidt Ocean Institute) that have more reach (i.e. social media followers) than academic researchers and have a natural interest in promoting and communicating science to share UN-MAE news and goals more broadly.
- *Prize organizations*: Partnership with a prize-oriented organization can help to build new engagement and create solution-oriented innovations for studying ocean sound. Two organizations were mentioned: Earthshot Prize (https://earthshotprize.org/) and XPRIZE Foundation (https://www.xprize.org/).

In terms of UN-MAE goals that can contribute to public engagement, the Ocean Stethoscope ocean shot (see: https://www.ingentaconnect.com/content/mts/mtsj/2021/00000055/00000003/art00049) would be a great tool, if realized, for engaging the public in listening to the ocean. The Ocean Stethoscope could engage students at a young age, generating interest in ocean sound and acoustics as an education and career pathway. There should be a component to the platform that demonstrates and explains differences in sounds and how they are heard in different ocean realms and provide context for what that means in terms of the ocean environment and marine life.

Collaboration Opportunities and Follow-up Actions

To maintain workshop momentum and build actionable steps, collaboration opportunities were documented that leverage capacity and maximize impact across programs and can be transitioned into 'implementation' plans.

Key collaboration opportunities and follow-up actions that could help advance the workshop outcomes are:

1. Jennifer Miksis-Olds agreed to reach out to John Pennock (NOAA Sea Grant program) to learn more about Sea Grant programs that include acoustic research.
2. Kerri Seger agreed to have the workshop report translated into different languages in order to reach diverse audiences. Potential languages for translation were based on the top languages spoken: Spanish, Portuguese, Arabic, French, Mandarin, Hindi, Japanese, Russian, Punjabi, Bengali.
3. Heather Spence, Jason Gedamke, Kerri Seger, and Kyle Becker agreed to schedule a follow-up meeting on video games with underwater worlds and sound.
4. Allison Miller agreed to help edit the workshop report and use Schmidt Ocean Institute's social platforms for report outcomes.
5. Erica Staaterman and Vincent Pieribone will follow up on their initial discussion of hosting an ocean soundscape exhibit at UN Ocean Conference.

6. Heather Spence agreed to determine a soundbite for World Listening Day on July 18th and continue to integrate ocean sound programming into World Listening Day over the course of The Ocean Decade.
7. The workshop planning committee will determine soundbites for use by the UN-MAE programme's communication efforts.
8. The workshop attendees agreed that the soundbites created during the workshop should be reviewed for inclusivity and be translated into a variety of languages. It was suggested that this be a role the UN-MAE programme should address.
9. UN-MAE and workshop participants (informally) agreed to determine how to sustain continued gatherings and maintain open communication across sectors.
10. Heather Spence will present the concept of adding a NIST representative to the Interagency Working Group on Ocean Sound and Marine Life.
11. John McGunnigle agreed to approach Amazon and Spear AI regarding creating a partnership for centralizing, storing, and curating publicly available data sets. At the time of this report, this action has resulted in a commitment from Amazon and Spear AI.
12. Jennifer Miksis-Olds will solicit feedback on the proposed soundbites from the ocean sound community at the Effects of Noise on Aquatic Life Conference in July 2022.
13. All workshop participants agreed to continue to identify and reach out to new partners and stakeholders as seen fit.

This workshop was a starting point in building collaboration across the ocean sound community, using the opportunity of the UN Ocean Decade and the endorsed UN-MAE programme to leverage activities and contributions toward common goals around ocean literacy and increasing data and technology capacity.

A key theme across all of the discussions was the issue of communicating the value of ocean sound information and understanding. The ocean sound community tends to be limited by its use of highly technical terminology and need to seek partners to help with outreach and communications efforts that can translate technical information to general audiences. Potential partners for this were identified and strategies to engage with them should be developed.

An exciting new partnership commitment arose as a result of the discussions around data archiving and access. The partnership between Amazon Web Services and Spear AI will develop a repository of acoustic data that will allow researchers and industry partners to access data in a user-friendly cloud-native manner. This is truly a step forward for the ocean sound community and has potential to grow into additional applications.

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- Heather Spence, U.S. Department of Energy (Co-Chair)
- Carl Kaiser, Saildrone
- Bruce Martin, JASCO Applied Sciences
- John McGunnigle, Saildrone
- Patricia Miloslavich, Scientific Committee on Oceanic Research
- Vincent Pieribone, OceanX
- Allison Miller, Schmidt Ocean Institute

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