

Annual Report from the International Quiet Ocean Experiment (IQOE) to SCOR August 2021

Note: Although the COVID-19 pandemic made it impossible to hold in-person meetings to advance goals of the International Quiet Ocean Experiment (IQOE) from early 2020 until now and hindered acoustic observations related to the project, IQOE continued making progress.

The [International Quiet Ocean Experiment Science Plan](#) was released in 2015 and a project Science Committee (SC) was formed that year by the two organizational sponsors, the Scientific Committee on Oceanic Research and Partnership for Observation of the Global Ocean.

The current members include the following:

Co-chairs

George Frisk, Florida Atlantic University/Woods Hole Oceanographic Inst. (USA)
Peter Tyack, Sea Mammal Research Unit, University of St. Andrews (UK)

Other Members

Olaf Boebel, Alfred Wegener Institute for Polar and Sea Research (Germany)
Christ de Jong, TNO (The Netherlands)
Robert McCauley, Curtin University (Australia)
Jennifer Miksis-Olds, University of New Hampshire (USA)
Hanne Sagen, Nansen Environmental and Remote Sensing Center (Norway)
Steve Simpson, University of Exeter (UK)
Jakob Tougaard, Aarhus University (Denmark)
Alexander Vedenev, P.P Shirshov Inst. of Oceanology, Russian Academy of Sciences (Russia)

Project Manager: Ed Urban

The terms of reference for IQOE are

- Advocate for and coordinate international activities of the IQOE Science Plan
- Review and report annually on progress in project implementation
- Refine the future project agenda annually and propose updates to the Science Plan as necessary
- Develop and oversee any subcommittees, working groups, and task teams necessary to implement international activities related to the IQOE Science Plan
- Establish and oversee the IQOE International Project Office (IPO) and its staff
- Serve as a resource for national committees
- Organize planning workshops as needed to establish research and observational priorities
- Promote partnerships with other projects and organizations to achieve IQOE goals
- Promote discussion about IQOE benefits with and among all stakeholders

- Endorse proposals for activities that are directly within the IQOE Science Plan or whose results can add to IQOE
- Define IQOE products
- Seek financial resources from national and international funding sources to support the implementation of IQOE
- Foster dissemination of the findings of the IQOE program
- Define indicators and metrics for evaluation and demonstration of IQOE progress

The IQOE SC has overseen the work of the project, which has been focused in the following areas so far:

1. **Physical and biological acoustic standards:** An important feature of every global research project involves creating a shared knowledge of available standards and agreement to protocols for collection and processing of data by project participants. IQOE's WG on Standardization issued an [Inventory of Existing Standards for Observations of Sound in the Ocean](#) in 2018 and [Guidelines for Observation of Ocean Sound](#) in 2019. The IQOE WG on Marine Bioacoustical Standardization produced an [IQOE Inventory of Existing Standards and Guidelines Relevant to Marine Bioacoustics](#) in June 2021. This group will continue its work to identify and promote best practices from the standards and guidelines listed in this inventory.

Outcomes: These groups are serving as a catalyst for development of international standards for ocean acoustic experiments like IQOE and laying a foundation for future work, such as the standardized data processing described in the next point.

2. **Ocean Acoustic Data Processing and Archiving:** A major barrier to creating global products related to ocean sound is that sound observations are made by many individuals, in different nations, using 20 or more different hydrophone types. The Richard Lounsbery Foundation supported a group of acousticians to create [Making Ambient Noise Trends Accessible \(MANTA\) Software](#) to process sound files in a way to make them comparable worldwide, by incorporating hydrophone calibration information and building in ISO and IQOE standards. In parallel, the Alfred Wegener Institute in Bremerhaven, Germany is developing the Open Portal to Underwater Sound (OPUS), which is expected to be launched by the end of 2021. OPUS will allow easy access to MANTA-processed data via map- and time-based selection tools and shopping basket functions.

Outcomes: MANTA and OPUS will make it possible to construct, archive, and serve global datasets of ocean acoustic data. These datasets will be vital for making time series of acoustic data at frequencies important for understanding marine life for multiple locations worldwide.

3. **Global hydrophone network:** At the open science meeting that was the basis for the *IQOE Science Plan*, a list of ocean sound observing assets was compiled and published in the *Plan* in 2015. This list was made available on the IQOE Website at <https://www.iqoe.org/systems>. In 2020, the IQOE Project Manager began collecting metadata on non-military hydrophones deployed in different parts of the world, to enlist the help of hydrophone operators to determine whether COVID-19 caused an observable decrease in ocean sound (see below). The inventory on the IQOE Website was updated in early 2021. Hydrophone operators also began providing metadata about deployments before and after the pandemic, so that the current number and positions of hydrophones and the course of deployments over time can be determined. (It must be recognized that not all hydrophones from around the world are participating in the network.) The potential of this network was described in an article in [Eos](#) in March 2021.

Outcomes: The global hydrophone network could become the central element to measure the Ocean Sound Essential Ocean Variable (see next item). It represents the first attempt to coordinate global ocean sound observations worldwide.

4. **Ocean Sound Essential Ocean Variable (EOV):** An IQOE panel supported by the Partnership for Observation of the Global Ocean (POGO) proposed that the Global Ocean Observing System (GOOS) adopt Ocean Sound as an Essential Ocean Variable. GOOS agreed and assigned IQOE the responsibility to work on implementation of this EOV. IQOE formed a [committee](#) in 2020 to write an implementation plan for the Ocean Sound EOV and the committee's work is ongoing at this time. The plan is expected to be completed in late 2021 or early 2022.

Outcomes: The Ocean Sound EOV Implementation Plan will make it possible to implement the measurement of ocean sound as a variable that can be measured widely worldwide as part of the Global Ocean Observing System as a measure of ocean processes and of the health of the ocean.

5. **Examination of COVID-19 Ocean Quieting:** As mentioned in item #3 above, the hydrophone network idea originated because of the COVID-19 pandemic and the opportunity this presented to look for effects of the pandemic on ocean sound. The IQOE Project Manager proposed a [Research Focus](#) for the journal *Frontiers in Marine Science* to provide an outlet for COVID quieting publications, among other topics. About half of the papers published in this Research Focus so far are related to the COVID quieting. Finally, IQOE is discussing a virtual workshop in late 2021 to bring together authors who have published papers related to the COVID-19 quieting to produce a synthesis publication.

Outcomes: Observations of the changes in ocean sound that resulted from the COVID-19 pandemic will help managers understand how much that different levels of change in

human activities will impact ocean sound, such as decreased shipping and slowing of ships.

6. **Acoustic biodiversity:** A WG on Acoustic Measurement of Ocean Biodiversity Hotspots was formed to examine the potential to use the diversity of sound produced by marine organisms as an adjunct to visual methods of assessment. The group published a review paper in August 2020 on this topic:

Mooney, T.A., L. Di Iorio, M. Lammers, T.-H. Lin, S.L. Nedelec, M. Parsons, C Radford, E. Urban, and J. Stanley. 2020. Listening forward: approaching marine biodiversity assessments using acoustic methods. *Royal Society Open Science* 7:201287
<http://doi.org/10.1098/rsos.201287>.

The WG is planning a workshop to discuss the creation of a global library of underwater biological sounds.

Outcomes: This WG is helping bring international focus on the use of biological sounds to augment other measures of biodiversity. Sound has the advantage that it can remotely sense biological activity continuously.

7. **Sound in the Arctic Ocean:** A WG on Arctic Acoustic Environments has been engaging with the Arctic observing community to promote the collection of sound as a key parameter in the Arctic Ocean. The group presented a poster at [OceanObs'19](#) and held a [virtual conference](#) on Sound in the Arctic Ocean on 11-12 November 2020. Conference participants asked that the event take place again in about two years.

Outcomes: The work of this WG is bringing attention to the Arctic policy and science community that sound is an important parameter to include in Arctic Ocean observing systems.

8. **Communication:** IQOE maintains a [Website](#), issues a newsletter three times each year, and began distributing news via an IQOE Twitter feed (@IQOE_Int) earlier in 2021. In addition, articles about IQOE have been published in [Oceanography Magazine](#), [Eos](#), and [ECO Magazine](#), a [poster](#) was presented at OceanOb'19 about IQOE, and an [opinion piece](#) was published in April 2021.

Outcomes: IQOE's communication activities bring an objective source of information about ocean sound to the attention of the public, policymakers, and the science community.

Plans for Remainder of 2021 and 2022

IQOE is at its mid-term, with a planned completion in 2025. The project has been able to accomplish a variety of useful tasks and produce some notable products, as described above. In addition to these tangible products, IQOE has (1) enhanced the visibility of endorsed national and regional projects at an international level, through the *IQOE Newsletter* and Website, (2) encouraged networking among [IQOE-endorsed projects](#), and (3) increased the visibility of the importance of ocean acoustics in many nations.

Plans for 2021

With the resources currently available, the following activities will be facilitated by IQOE and related projects in 2021:

- Continued maintenance of the hydrophone network metadata and encouraging hydrophone operators to submit their MANTA outputs to OPUS
- Completion of the Ocean Sound EOV Implementation Plan
- Virtual or in-person meeting of the IQOE Science Committee
- Virtual meetings of subgroups of the IQOE WG Acoustic Measurement of Ocean Biodiversity Hotspots. Topics for these subgroups have already been identified by the WG and conference calls are being scheduled.
- Continued outreach of the WG on Arctic Acoustic Environments to Arctic acoustic science and policy communities. Completion of the summary from their virtual workshop in 2020.
- Interface of IQOE Data Management and Communication WG with OPUS

Plans for 2022

- Creation of MANTA-based data product and synthesis publication of COVID impacts.
- Follow-up for Ocean Sound EOV Implementation Plan