

The Discovery of Sound in the Sea Project: Twenty Years of Success in Synthesizing Science for Nonexperts

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In November 2021, the Discovery of Sound in the Sea (DOSITS; see dosits.org) project celebrated its 20th anniversary and will be celebrating the 20th anniversary of the project website in 2022. Over the past 20 years, the DOSITS team has published a number of articles in *Proceedings of Meetings on Acoustics (POMA)*, *Acoustics Today*, and other publications that share information about the project and resources on the website (Vigness Raposa and Scowcroft, 2008; Vigness Raposa et al., 2012, 2017; Scowcroft and Vigness-Raposa, 2014; Scowcroft, 2016). The purpose of this essay is to share a bit of the project's history that has not been previously shared.

Overview

Over the past 20 years, the DOSITS project has evolved from a simple site that contained approximately 100 pages and a few dozen articles to a unique resource with over 450 pages and a diversity of resources that include, among others, structured tutorials (see dosits.org/tutorials), educational activities (see dosits.org/resources), and archived webinars (see dosits.org/decision-makers/webinar-series). Traffic on the DOSITS website has grown from having 10,000 views in its first full year to having over one million page views in 2020, and the number of site users continues to grow. Moreover, DOSITS is now used by people from countries all over the world.

The DOSITS website has become the “go-to” site for understandable and authoritative information about all aspects of underwater sound, from the basic physics of sound to the use of sound by aquatic animals to the effects of anthropogenic sound on these animals (and on the acoustics associated with these sources). Moreover, over time, DOSITS has evolved to serve an amazingly broad community from K-12 students to scientists wanting to learn more about particular topics to regulators, members of environmental groups, and industry personnel. Those

involved with the production of DOSITS content and resources have worked to ensure the scientific integrity of these materials, thereby ensuring that users are getting up-to-date peer-reviewed science.

Origin and Evolution of DOSITS

In 2001, an interdisciplinary team of scientists and education professionals began DOSITS. The project was initially intended to address the need for educating the public about underwater acoustics and related research. This need had been exemplified by public resistance to the Acoustic Thermometry of Ocean Climate (ATOC) experiments off Hawai'i, which were using sound underwater to study ocean temperature changes. The ATOC program's early goal was to measure average temperatures in the North Pacific Ocean along a number of paths. Acoustic sources off central California and north of Kauai, Hawai'i, transmitted sound to US Navy receivers, providing a network of acoustic paths. This allowed the scientists to observe large-scale seasonal changes in ocean temperature. The scientists believed that if the transmissions continued for many years, large-scale climate change in the ocean could be measured. There was some public opposition to this research because people believed that the underwater ATOC sound source would harm humpback whales in the vicinity. However, research at the time had shown that it was unlikely that the sound source, operating at approximately 195 dB, would harm the whales (Mobley et al., 1988; Au et al., 1997; Frankel and Clark, 1998).

In response to the need for providing the public with accurate scientific information in nonexpert language, Peter Worcester of the Scripps Institution of Oceanography, La Jolla, California (one of the ATOC project's lead scientists) approached his colleague Kathleen Vigness-Raposa (then with Marine Acoustics, Inc., Middletown,



Figure 1. Examples of the Discovery of Sound in the Sea (DOSITS) home pages from 2006 (top) and 2021 (bottom). Images courtesy of Christopher Knowlton.

Rhode Island) in 2000 to assist with the production of a public friendly website on the topic of using sound underwater. In turn, Vigness-Raposa approached me and my team at the University of Rhode Island Graduate School of Oceanography, Narragansett, Rhode Island, due to our expertise in translating complex science for nonexperts, and the DOSITS team was established. Vigness-Raposa and I were successful in securing funding from the Office of Naval Research, Arlington, Virginia, to develop the first DOSITS website. This early DOSITS site (Figure 1) provided content on the basic science associated with underwater acoustics, and the content was written at the education level of the average newspaper reader so that it could be understandable by the public.

A decision was made by the DOSITS project leaders to draw exclusively from peer-reviewed literature for DOSITS web and print content. Supplemental content from governmental reports has been allowed when necessary. The DOSITS Scientific Advisory Panel (AP) was established to review all content created by the team and

to suggest new content for inclusion on the site. For 20 years, the DOSITS AP has met each year for two 2.5-day sessions to review and edit all DOSITS content and materials. In addition, the AP members often assist with content development when their expertise is needed.

Beginning in 2000, a core AP, composed of Peter Worcester, Kurt Fristrup, Peter Scheifele, and James Miller, was joined by subject-matter experts from the underwater acoustics community as needed for content review. Following this, the core AP was joined by Darlene Ketten, Arthur Popper, and Danielle Cholewiak. In addition to the DOSITS core AP members, DOSITS content has been reviewed by over 45 members of the underwater acoustics community, and resources, images, and sound files have been provided by dozens more. The success of the DOSITS project has mainly been due to the integrity of the scientific content of DOSITS resources and the goodwill of the underwater acoustics community.

Although DOSITS began with a single educational purpose, the project quickly grew. To meet the needs of educators, media and news professionals, and decision makers, the DOSITS team has conducted content and resource needs assessments of these communities. Key content and resources have been developed based on these assessments, including structured tutorials, iBooks (see dosits.org/book), and an annual webinar series.

Since 2013, the DOSITS team has worked with the international regulator/decision-maker community to provide syntheses of the latest peer-reviewed science. The DOSITS annual webinar series for decision makers is a popular education medium for this community, with webinars routinely attended by hundreds of participants. The 2020 four-part webinar series (see acousticstoday.org/dosits-webinars) on (1) “Fundamentals of Underwater Sound,” (2) “Review of the NMFS Regulatory Approach to Underwater Noise,” (3) “How Passive Acoustics Data Are Used to Inform the Decision-Making Process,” and (4) “Regulation of Underwater Noise: An International Comparison” had over 1,465 individual webinar connections from 39 countries, and many of these connections provided access to groups of participants. The webinars are archived online following the live interactions and are a well-used resource. For example, the number of Internet connections to the live April 2021 webinar “Passive Acoustic Monitoring Overview-Applications for Marine Mammals and Fishes” was

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viewed 487 times. The archived webinar has been viewed an additional 334 times through July 2021.

DOSITS resources have also become a trusted source of information for several stakeholder groups, and the DOSITS website is the go-to source on information related to sound underwater for nonexperts. It is also used by undergraduate faculty across the United States as a supplement to their instruction. The website receives over one million page views a year.

The success of the DOSITS project is due to several elements. The engagement of the DOSITS AP and the broader underwater acoustics research community have been essential to the project's scientific integrity and value. Routinely conducting needs assessments of user groups has ensured that new resources meet the current needs of these groups and are produced in the most accessible formats. The DOSITS team is able to meet needs and fill content gaps based on interactions with the communities of users. In addition, dissemination of DOSITS resources through multiple national and international meetings and workshops over the years has helped to reach users.

The Future of DOSITS

Over the next year, the DOSITS team will be continuing to produce new content on topics, including "Ocean Noise Budgets," "Potential Effects of Sound on Marine Invertebrates," and "How Sound is Used to Protect Marine Mammals." The team is in the process of conducting a new needs assessment of the international regulatory/decision-making community and will be prioritizing the development of new content over the next four years based on these results.

As the DOSITS team looks toward the next decade, we will continue to disseminate the results of our work internationally and are working to expand our reach through activities associated with the United Nations Decade of Ocean Science for Sustainable Development (the Decade). The Decade's international ocean literacy initiatives will provide opportunities to work with groups of education professionals, decision makers, and business and industry leaders across the globe.

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