Discovery of Sound in the Sea
2015 Annual Report

Gail Scowcroft
Graduate School of Oceanography
University of Rhode Island
Narragansett, RI 02882
phone: (401) 874-6724 fax: (401) 874-6486 email: gailscow@uri.edu

Award Number: N00014-14-1-0157
http://www.dosits.org

Kathleen J. Vigness-Raposa, Ph.D.
Marine Acoustics, Inc.
809 Aquidneck Ave.
Middletown, RI 02842
phone: (401) 847-7508 fax: (401) 847-7864 email: kathleen.vigness@marineacoustics.com

Subcontract Number: 3918-032614

LONG-TERM GOALS

The long-term goal of this effort is to synthesize scientific research across the disciplines related to underwater acoustics and educate policymakers, regulators, the media, and the public on the basic science of sound in the sea; how people and animals use underwater sound; and how sound in the ocean affects marine life. The products of this effort include comprehensive on-line resources, printed materials, and an interactive iBook.

OBJECTIVES

The objective of this effort is to synthesize newly published research and develop associated content that addresses the long-term goal. Discovery of Sound in the Sea (DOSITS) content is available online (Figure 1), in an informational, 16-page booklet (currently available in English and Spanish), a tri-fold educational pamphlet (available in multiple languages), as well as an interactive iBook.

APPROACH

Efforts have focused on enhancing and expanding the research results and scientific content included in the *Discovery of Sound in the Sea* products, including a comprehensive website that was launched in November 2002. During the past thirteen years, Marine Acoustics, Inc. (MAI) and the University of Rhode Island's Graduate School of Oceanography (GSO) have developed a successful working relationship to create and maintain the DOSITS resources, while ensuring that newly published peer-reviewed science is incorporated in a timely fashion. Resources undergo regular updates and rigorous scientific review by a multisiciplinary panel of scientists in the field, led by Drs. Peter Worcester

(Scripps Institution of Oceanography), James H. Miller (University of Rhode Island), Darlene Ketten (Jefferson Science Fellow, National Academy of Sciences and U.S. Dept. of State, Harvard University Medical School, and Woods Hole Oceanographic Institution), and Arthur N. Popper (University of Maryland). MAI and GSO make all final decisions on the site content.

Figure 1: Mobile-friendly front page of "Discovery of Sound in the Sea" website includes new sections titled "What's New" and "Hot Topics" as well as resources for Decision Makers, (http://www.dosits.org)

WORK COMPLETED

During the thirteenth year of research, MAI and GSO focused on several tasks to enhance and expand the online resource that was launched in November 2002, and to reach additional audiences that have not been targeted in the past. These tasks included the following:

1. Creation of readily available resources for regulators, a key stakeholder group from which the DOSITS team has received increasing inquiries. Regulators have needs for comprehensive, easy to understand, and rapidly accessible resources that will aid in making decisions related to underwater sound.

A. In the Spring of 2015, the DOSITS team conducted a second needs assessment of the regulator community via an online survey. Over 160 participants from 29 countries, directly involved in regulation, supporting regulators, or representing industry, provided data for the needs assessment. Seventy-five percent of the respondents work in support roles for regulatory decisions (one major difference between this survey and the Spring 2014 DOSITS regulatory needs assessment). Over 50% of the respondents have two weeks or more of training opportunities per year, and most of their training opportunities come from on the job experience as well as meetings and conferences. Web resources were the highest rated tool for assisting with decision-making, followed by in-person, 1-2 day workshops.

B. Results from the 2014 and 2015 needs assessments showed that decision makers use peer-reviwed literature in the regulatory process, but have a difficult time obtaining these rources. To meet this need, the DOSITS team created a "master list" of peer-reviewed references cited in the Animals and Sound content sections. The *Animals and Sound Suggested Reference List* is available under the Resources section for Decision Makers.

C. In response to 2014 and 2015 regulatory needs assessment results (and in consultation with the DOSITS Advisory Panel), the DOSITS team created an online tutorial about the potential effects of sound on marine animals. The *Effects of Sound Tutorial* presents a progression of content supported by peer-reviewed material available on the DOSITS website. It discusses the potential impacts that increased background noise and specific sound sources might have on marine animals, including behavioral changes, masking, hearing loss, and physiological effects. The tutorial was released in April 2015 and announced through a variety of U.S. and international outlets. A second tutorial covering the process to determine the risk of marine animals being exposed to underwater sound is under development and will be reviewed with the DOSITS Advisory Panel in December 2015.

D. To the assist with the development of future DOSITS tutorials and other resources for the decision maker community, the DOSITS team issued a useability survey on the *Effects of Sound Tutorial.* The survey had 21 respondents who were mostly government employees (50%) and were evenly split between those who make decisions and those who supply information to decision makers. About 50% of the respondents indicated that the tutorial met their needs extremely or very well, about 25% felt it met their needs moderately well, and about 25% felt it met their needs not very well or not at all. Responses indicated that participants' dissatisfaction stemmed from a misunderstanding of how the tutorial was structured. A new introductory page has been created to outline the tutorial and provide a basic description of its functionality. All the sections were found "useful" (rating 4 of 5) on average. The quality of each section was rated very uniform as well, with all sections averaging "above average quality" (rating 4 of 5).

   The survey respondents found the information in the tutorial extremely easy or very easy to understand (71%) and the rest found it moderately easy to understand. The respondents generally trust the DOSITS website (76% trusted it a lot or a great deal). About 50% were likely to recommend the tutorial to their colleagues. Based on the feedback in the survey, changes were made to the existing tutorial, and those recommendations will be carried into the future tutorials. Many of the stated needs will be met by the content of the next planned tutorial.

E. The DOSITS team has developed an interactive iBook, *Importance of Sound in the Sea*, which focuses on how animals produce, receive, and use sound and provides an overview of the potential effects of sound on marine life. The iBook elevates existing and updated DOSITS content through the inclusion of significantly more imagery, video, and audio, in various playback formats. This iBook will serve as a tool to make the science of underwater sound available to the decision-making community, as well as afloat military personnel, via their hand held and tablet devices.

F. In 2014, a new front page feature that highlights "hot topics" in underwater acoustics was added to the DOSITS homepage. This feature allows for current and topical issues to be highlighted along with links to the foundational scientific content on the DOSITS site. New "Hot Topics" currently highlighted on the DOSITS site include a discussoin of ocean-based renewable energy and the potential effects of noise produced by wind, wave, and tidal technologies. Another "Hot Topic" on ship noise and quieting technoloiges is in development. The DOSITS team will continue to synthesize scientific journal articles from recently published literature that may be of prime interest to DOSITS audiences, especially those of the regulatory community.

2. Addition of "How do we know" to the DOSITS Facts and Myths Quiz. The DOSITS Facts and Myths Quiz was developed in response to the needs assessment conducted with media and public affairs officers. It was clear that a media resource was needed that highlighted the critical points in the science of underwater sound. In addition to including an informative response to the question posed, the DOSITS team has expanded each response to include a short explanation of how scientists know the given information. The expansions highlight the scientific process for understanding these critical points, educating media and public affairs professionals, as well as regulators, on key issues and related science.

3. Updates to the *Science of Sound in the Sea*
After review of the new DOSITS content on "phase" with the DOSITS Advisory Panel, it was decided that an Advanced Topic on the subject was necessary. The concept of "phase", which denotes a particular point in the cycle of a wave, is introduced in the Science of Sound section, "How do you characterize sounds?", but more complex details, a sequence of figures that include labeled plots identifying key components, and equations are available on the Advanced Topic page. A link to this Advanced Topic is included in the bulleted list at the bottom of the "How do you characterise sounds?" basic content page.

4. Updates to the *Animals and Sound in the Sea*

A. Revised and updated Animals > Use of Sound > Marine Mammals > Feeding

B. Revised and updated Animals > Marine Mammal Sound Production

C. Revised and updated Animals > Potential Effects > Marine Mammals

D. Revsied and updated Animals > Potential Effects > Marine Fishes

E. New content on the hearing abilities of marine fishes and how scientists "know" what fishes can hear is under development. Particle motion vs. pressure detection in fish, sound source discrimination and directional hearing, low frequency sound reception in elasmobranchs, and other topics will be discussed in these new sections.

F. New content describing pile driving sources and characterizing their potential effects on marine animals is under development. This will be the first part of a new section under Animals and Sound > Potential Effects: Anthropogenic Sound Sources. Pile driving was the one of the highest ranked sound sources for which regulatory needs assessment participants indicated they would like more information. Underwater sounds associated with shipping and explosive sound sources also ranked highly.

G. Reviewed recently published, peer-reviewed literature to update existing scientific content, particularly the effects of underwater sound on marine life.

5. Updates to the *People and Sound*

   A. New content > People > National Defense > How is sound used to monitor and defend harbors? With the increase of terrorism in the U.S. and on U.S. assets in foreign ports, there is an elevated need to monitor and defend harbors and at-sea equipment. Diver and mine detection systems that utilize underwater acoustics are described in this new content. Underwater acoustic systems utilized as stop-gate mechanisms for identifying unauthorized access or disturbances to the underwater environment are also discussed.

   B. Existing content on how sound is used to locate and identify marine fishes, as well as study their distribution, is being updated to reflect new technologies and recently published peer-reviewed science. The content will be reviewed with the DOSITS Advisory Panel in December 2015.

6. Expansion of the Audio and Technology galleries. Contacts are continually made with researchers studying and using underwater sound, to provide material for revising and expanding the existing content in the Audio Gallery and Technology Gallery. Since these sections attract a high volume of web traffic, they need to be revised and updated on a timely basis.

   A. New sounds added to the DOSITS Audio Gallery in the last year include underwater recordings of northern bottlenose whales, Lusitanian toadfish, submarine volcanic erruptions, and SCUBA bubbles. In addition, longer audio files continue to be added when possible.

   B. Existing content in the Technology Gallery discussing acoustic datalogging systems and acoustic fish tags will be updated and expanded in accordance with content under revision in associated People and Sound sections. These updated content sections will be reviewed with the DOSITS Advisory Panel in December 2015.

7. Enhancements to the DOSITS website. Raytheon Web Solutions (RWS) has continued the efforts started in 2014 to make the site more responsive and mobile device friendly. The DOSITS team is removing dependency on Flash-based content from the site and particularly the galleries. The left side navigation is being simplified with some menu items moving to other parts of the page. A new menu system for sub-pages will improve the ease of discovering "deep" content. The new menu will also be more user friendly on both traditional displays and mobile devices. Several back end server advancements will improve administration of the site.

8. Printed DOSITS public affairs publications. The DOSITS educational booklet provides an in-depth look at underwater sound and targeted issues for interested stakeholders, policymakers, and

the public. To reflect content edits, as well new content added to the DOSITS site, the booklet is currently under revision and will be reprinted in the fall of 2015.

9. Continued addition of cross-links between existing content. While an attempt was made to integrate new material with existing content, additional cross-references were needed among content pieces to provide a broader understanding of underwater sound. In addition, with twelve years of detailed web traffic data, cross-links from web pages that receive high amounts of web traffic, such as the Audio Gallery, can draw the user into pages that have traditionally received less traffic.

10. Further promotion of the DOSITS project. The DOSITS project was promoted at the 2015 Navy Expo in Washington, DC, as well as the National Marine Educators Association (NMEA) Meeting, which took place in Newport, Rhode Island. Internationally, an overview and timeline of resource development for the regulatory and decision maker community was provided at the 2015 Ocean Noise meeting in Barcelona, Spain. Online resources for decision makers will also be presented at the 21st Biennial Conference on Marine Mammals, which will take place in San Francisco, California, in December 2015.

11. Conducted peer review of online resources and other materials. Review meetings with the DOSITS Scientific Advisory Panel were held at URI/GSO during December 2014 and June 2015 to review new and revised content and other DOSITS materials. A December 2015 Advisory Review Meeting is also being planned. The DOSITS AP puts all DOSITS content and associated resources through a peer review process to ensure scientific integrity. In addition to the advisory team, the DOSITS scientific content has been reviewed by over 40 scientific experts (see http://www.dosits.org/about/ for a complete list). Rotating advisory panel members are added as appropriate to review specific scientific content as it relates to their expertise.

RESULTS

The DOSITS resources have received an overwhelming response. The website was first launched in November 2002. Through August 2015 the DOSITS site has seen more than 86 million hits and more than 7.5 million page views (Figure 2). In the 12-month period ending August 2015, DOSITS had 1 million page views, corresponding to 980,000 visits, about a 30% increase over the previous 12-month period (Figure 3).

In the last year, mobile devices accounted for 30% of the visits to the site. Visitors to the site primarily came from North America (52%), with Europe (19%), Asia (18%), and Australia and Pacific Islands (5%) rounding out the other half of the visits. These data are from Google Analytics.

IMPACT/APPLICATIONS

The DOSITS website and printed publications are resources for educating and exposing decision makers, stakeholders, and the public to the basic science of sound in the sea and how it is used to communicate, navigate, and explore the oceans. By providing information in multiple formats, policy makers have rapid access to up to date scientific research results, public affairs personnel can inform themselves of controversial issues and provide materials to Congress; the public can begin to include science in their decisions, and educators can bring this content into their classrooms. DOSITS is recognized as a resource by established journal outlets, as evidenced by our involvement in the January

2011 issue of National Geographic "The Big Idea" section (http://ngm.nationalgeographic.com/2011/01/big-idea/noisy-ocean).

TRANSITIONS

DOSITS is recognized as the world leader in the scientific synthesis of and education and outreach on underwater acoustics. With the appropriate permissions, the National Oceanic and Atmospheric Administration has incorporated components of the DOSITS Audio Gallery into its exhibit "Sounds of the Sea" for the Smithsonian Institution's National Museum of Natural History Ocean Hall "Oceans Today" kiosks. These kiosks are located at the entrance to the Ocean Hall, thereby making it one of the first components that visitors to this newly constructed exhibit will encounter. This prominent placement ensures a very broad impact from the work of the DOSITS team.

RELATED PROJECTS

None.

PUBLICATIONS

"Discovery of Sound in the Sea" website

"Discovery of Sound in the Sea" CD-ROM

Scowcroft, G., Vigness Raposa, K., Knowlton, C., and Morin, H. 2015. Discovery of Sound in the Sea. University of Rhode Island. (16-page information booklet)

Scowcroft, G., Vigness Raposa, K., Knowlton, C., and Morin, H. 2015. Discovery of Sound in the Sea. University of Rhode Island. (tri-fold pamphlet)

Vigness-Raposa, K.J., Scowcroft, G., Knowlton, C., and Morin, H.M. 2014. Underwater Acoustics for Everyone. Acoustics Today. 10 (2): 50-59.

Vigness-Raposa, K.J., Scowcroft, G., Miller, J.H., and Ketten, D.R. 2012. Discovery of Sound in the Sea: An on-line resource. *In*: The Effects of Noise on Aquatic Life (Arthur N. Popper and Anthony Hawkins, eds.). Springer, New York.

Vigness-Raposa, K.J., Scowcroft, G., Knowlton, C., and Worcester, P.F. 2008. Discovery of Sound in the Sea Website: An educational resource. Bioacoustics 17: 348-350.

HONORS/AWARDS/PRIZES

2007 Acoustical Society of America Science Writing Award for Media other than an Article

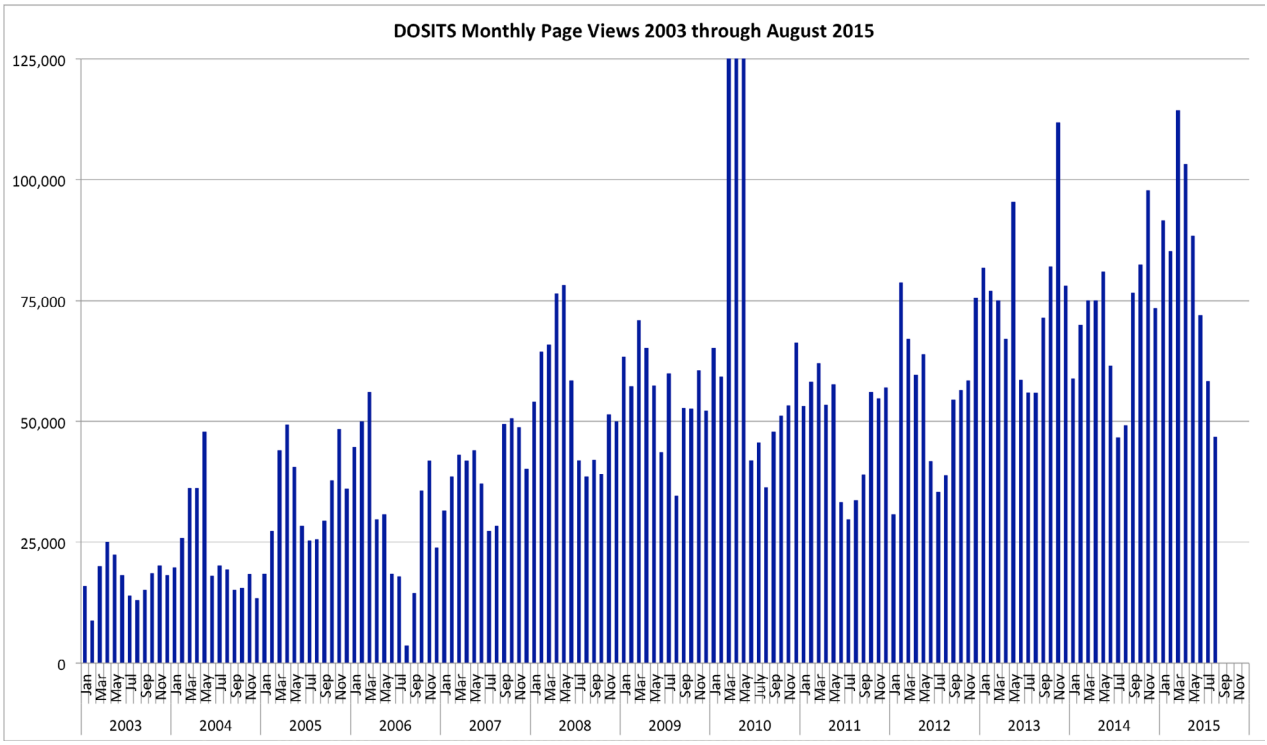

Figure 2: "Discovery of Sound in the Sea" website (http://www.dosits.org) traffic shown as page views from 2003 through August 2015.

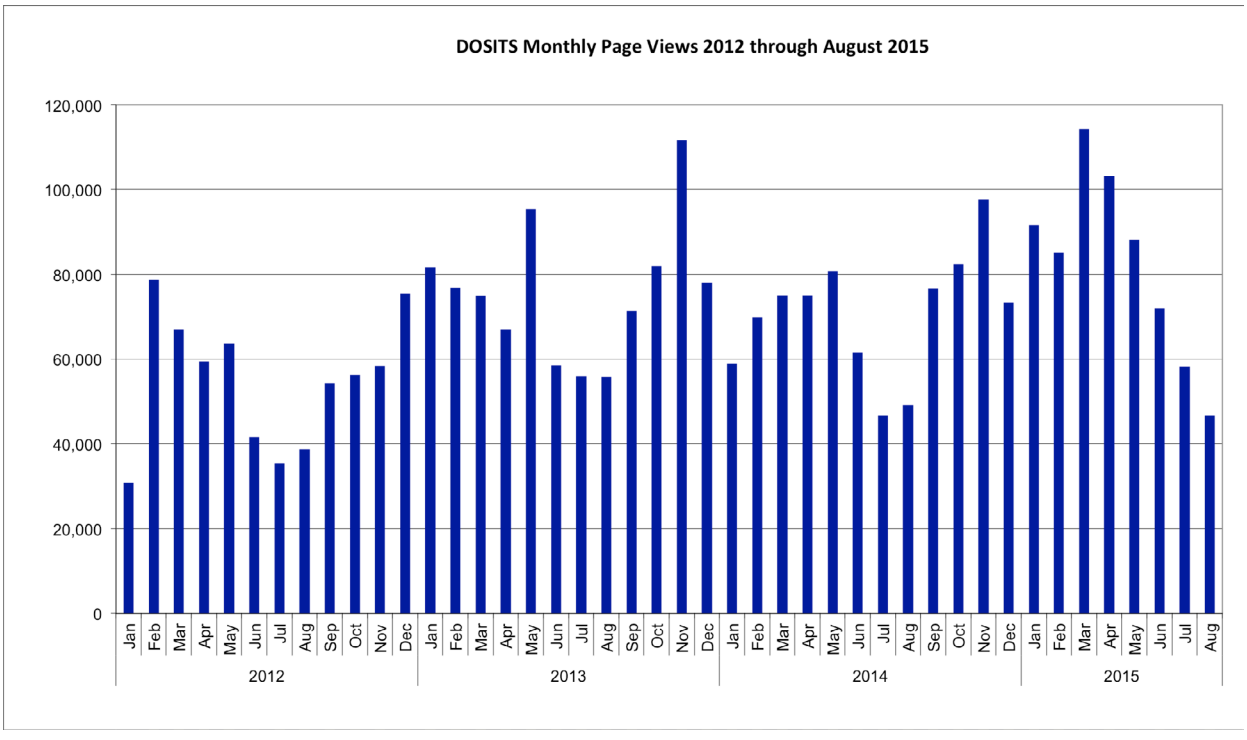

Figure 3: "Discovery of Sound in the Sea" website (http://www.dosits.org) traffic shown as page views from 2012 through August 2015.