WORKING GROUP ON PASSIVE ACOUSTIC MONITORING STANDARD

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Members of the Working Group who were at the ASA Meeting in Minneapolis. Left to right: Aaron Thode, James Miller (standing), David Mellinger, Jeremy Nedwell (standing), Ann Bowles, and Edmund Gerstein. Note that we need YOUR help. You are missing from the meeting and the photo.

It has been known for decades that many marine animals make underwater sounds ranging in frequency from 10 Hz to over 100 kHz. Associating various sounds with specific species has been an active research topic to which members of the Acoustical Society of America (ASA) have made substantial contributions. A good start on this topic can be found in Reference 1 or by consulting the Macaulay Library of Sounds at Cornell University (http://www.birds.cornell.edu/macaulaylibrary/). Many researchers now focus their efforts to study under what behavioral, geographical, and seasonal circumstances an individual from a given species will produce a sound. For example, sperm whales (*Physeter macrocephalus*) produce a vocalization called a "coda," which is a series of 3-10 clicks arranged with a certain rhythm[2,3]. Recording from groups of sperm whales across the globe has shown regional variations in coda activity[4,5,6]. It is unclear at this point whether coda differences can be used to describe genetically distinct populations. In general there remain many uncertainties about the use of passive acoustic monitoring (PAM) for detecting individuals or estimating marine animal population sizes. For an example of one of the most successful attempts at acoustic censusing see Reference 7.

Despite these uncertainties, there have been many efforts over the past two-decades to use PAM as a tool to complement visual observations as a means to detect the presence of marine mammals in areas where high-impact anthropogenic activity is underway, defined here as "mitigation." The use of PAM methods, which typically involve towing a two- or three-element passive array a few hundred meters behind a ship, has spread beyond the research community and is now being used by various government agencies, non-government organizations, and consultants. Several industry segments are actively pushing for the development and implementation of PAM procedures for marine mammal mitigation. One of the most active proponents of PAM has been the seismic exploration industry, which often uses arrays of devices called airguns to produce high-amplitude impulses that are used to image sub-seafloor structure by recording the reflected and refracted returns on passive hydrophones[1,8,9].

In June 2005 the ASA Standards committee formed a working group to determine whether certain implementations of PAM technology have matured enough to warrant the development of an American National Standards Institute (ANSI) standard. The first meeting of the working group took place on October 19, 2005 during the 150th meeting of the ASA in Minneapolis, to begin discussions and draft a purpose and scope for a possible standard.

Based on comments from the seven people who attended the meeting, the following statements were drafted to explain the rationale behind the proposed standard.

(1) To establish a set of minimum procedures that would enable a technical nonspecialist to increase the likelihood of acoustic detection of a marine animal vocalization, if such a vocalization is made. The nonspecialist may not have been responsible for the selection of the equipment provided. Thus this standard stresses procedures, not equipment.

(2) To define a set of data archiving, documenting, and reporting procedures so results and conclusions from

different PAM activities can be objectively compared by a neutral observer. For example, PAM measurements made from a large ship and a small sailboat in the same area might reach different conclusions about the presence or absence of a particular species in the area. In this situation it would be important that information about the background noise levels recorded on both systems be declared in the report, as well as the sampling rates, dynamic range, and frequency response of the two systems.

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(3) To provide a set of minimum metrics for characterizing and reporting marine animal vocalization features, particularly those features that concern source level. It is hoped that greater consistency in reporting sound characteristics is achieved.

(4) To recommend a set of additional procedures that would allow data collected by non-specialists on non-research platforms to be used for research into marine animal source levels, directionality, and ocean sound propagation loss, which in turn may eventually have relevance to studies of sound impacts on marine mammals.

(5) To simplify drafting regulations, cruise plans, and reports by standardizing some basic procedures for collecting acoustic data for PAM purposes. Rather than reiterating these procedures, these documents may simply refer to the ANSI standard for the essential requirements.

(6) To ensure that reports that use PAM data for nonresearch purposes directly state the limits and uncertainties associated with PAM.

(7) To encourage the market to develop an expendable, calibrated sound source to allow PAM detection range to be empirically measured.

This standard would not cover active underwater detection of marine animals or nonacoustic means of detecting and ranging animals, nor address criteria for noise impacts on marine animal behavior and long-term viability of populations.

There have been concerns expressed that many PAM systems are still under development, and new hardware and software systems are tested all the time. Wouldn't an ANSI standard quickly become irrelevant, or worse, stifle innovation and research into the topic? To calm these concerns the draft outline of the standard stresses good procedure over specific equipment needs.

Another fundamental strategy behind the standard is to specify minimum amounts of information that need to be published in a PAM report to allow correct comparison between different activities. Thus much of the standard will consist of reporting requirements.

There are several issues that have caused some disagreement, such as whether a set of procedures for reporting source levels for different types of biological sounds (particularly impulsive sounds) can be standardized at this point. Therefore, among others, the opinions of Acoustical Society of America members from all technical committees are being invited, particularly members from Animal Bioacoustics, Underwater Acoustics, Acoustical Oceanography, and Signal Processing in Acoustics.

The last working group meeting occurred at the 16th Biennial Conference on the Biology of Marine Mammals, at the Manchester Grand Hyatt San Diego in San Diego, CA, on December 15, 2005. Twenty-five people attended the meeting, and much discussion took place about the need for and scope of a standard for passive acoustic monitoring. While strong opinions were expressed about the value or timing of such a standard, the group reached a consensus that a minimum standard should be defined that would specify minimum "metadata" that should be recorded during PAM activities, as a first step toward a possible standard for recording and reporting of acoustic data at sea. Clearly, the effort is still in its early stages, and individuals who are interested in helping to formulate the standard are encouraged to attend the next working group meeting at the next ASA meeting in Providence, RI on Wednesday, June 7. Individuals who are interested in helping to formulate the text for the standard are encouraged to attend this meeting, and sign up on the ASA-PAM-STANDARD mailing list using the URL: siomail.ucsd.edu/mailman/listinfo/asa-pam-standard. **AT**

References and Further Reading

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Aaron Thode received his B.S. degree in physics and master's degree in electrical engineering in 1993 from Stanford University. He received his Ph.D. in oceanography from Scripps Institution of Oceanography in 1999, with a thesis that focused on three-dimensional acoustic tracking and tomography of blue whale sounds off California. He was a postdoctoral scholar in ocean engineering at the Massachusetts Institute of Technology from 1999-2001, and is currently an associate research scientist at the Marine Physical Laboratory at the Scripps Institution of Oceanography, University of California, San Diego. His current research interests include modular array designs for advanced acoustic localization and tomography, 3-D tracking of odontocete sounds using towed array systems, and studies of sperm whale depredation. In 2003-05 he was a principal investigator for the Sperm Whale Seismic Study for the U.S. Department of the Interior's Minerals Management Service, gaining field experience with passive acoustic monitoring techniques. In 2002, he received the Office of Naval Research Acoustic Entry-Level Faculty Award. In 2005, Thode received the A. B. Wood Medal from the Institute of Acoustics (United Kingdom) "presented to an individual under age 35 for distinguished contributions in the application of acoustics," for his efforts in underwater acoustics and marine mammal bioacoustics.

150th ASA Meeting, Minneapolis—Officers and Members of the Executive Council (from left to right)—Allan D. Pierce, William A. Yost, Mardi C. Hastings, Donna L. Neff, Mark F. Hamilton, Anthony A. Atchley, Judy R. Dubno, Whitlow W. L. Au, Victor W. Sparrow, George V. Frisk, David Feit, Paul Schomer, Stephen C. Thompson, Diane Kewley-Port, William A. Kuperman, and Charles E. Schmid