LIVING MARINE RESOURCES PROJECT 6

Database and Metrics for Testing Automated Signal Processing for Passive Acoustic Monitoring

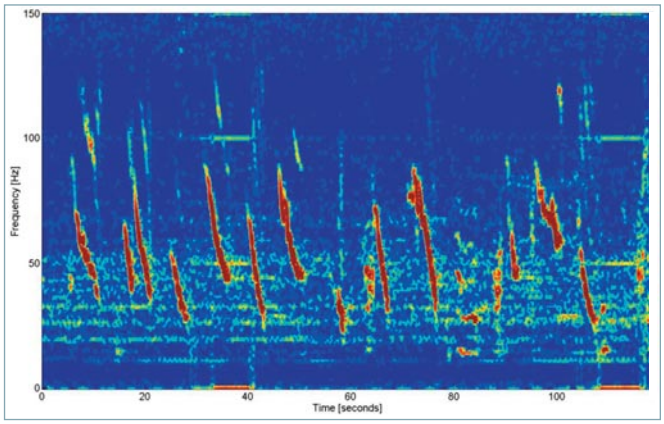
THE NEED

The Navy is responsible for compliance with a suite of Federal environmental laws and regulations that apply to marine mammals and other marine protected species, including the Endangered Species Act (ESA) and the Marine Mammal Protection Act (MMPA). As part of the regulatory compliance process associated with these Acts, the Navy is responsible for implementing a marine species monitoring program to assess potential impacts from Fleet and Systems Command (SYSCOM) military readiness activities involving active sonar and underwater detonations from explosives and explosive munitions. Passive Acoustic Monitoring (PAM) is a proven means of detecting and classifying vocally active marine mammals, as well as a number of fish species. Signal processing remains a technical challenge to non-expert wide-scale application of PAM technology. As PAM technology has advanced, long-term continuous monitoring systems have created large volumes of data and the need for concomitant advances in data curation, search, analysis, and visualization.

A comprehensive set of automatic marine mammal call detectors and classifiers is needed; one that covers the full range of species of interest at every training location. In order to develop algorithms for call detection and classification, a database of calls is needed. A standardized set of metrics is also needed to assess the performance of both existing algorithms and new algorithms that are being applied to process PAM data.

THE SOLUTION

Using an existing archive of acoustic recordings and detections, the project team is developing an extensive set of training and test data that will be used for developing automatic algorithms related to call detection and classification. This protocol follows the well-developed path of the Advanced Processor Build program utilized in the Anti-Submarine Warfare community. In addition, a committee of experts is being convened to develop metrics for algorithm performance.



Recorded blue whale "D" calls, often made during foraging activity.

The current state-of-the art for processing large PAM data sets in the Navy is a hybrid between manual scanning of the data and automatic call detection. This approach allows manual analysis of large data volumes, and the datasets analyzed in this manner are then available as a baseline against which to test automatic call detection and classification algorithms.

THE METHODOLOGY

During this project, Principal Investigator (PI) Hildebrand will collaborate with co-PI Marie Roch of San Diego State University and Sean Wiggins of Scripps Institution of Oceanography to construct marine mammal call datasets that can be used for development, testing and evaluation of PAM signal processing systems for each of the major naval training areas. Each dataset will be focused on particular species and signal types, and will sample the range of variability of the signal, the ocean noise environment in which the signals occur, seasonal variables, and the contribution of variations in the recording system. The team will

focus on species that are found across multiple naval training sites, that are relatively ubiquitous, and whose signals are well characterized, such as blue, fin and humpback whales, a variety of beaked whales, and Risso's dolphins. A category of unidentified cetacean signals will also be labeled.

Manually scanned Pacific Fleet and Atlantic Fleet PAM datasets are being used as they provide the requisite large data benchmarks (multiple deployment years at multiple sites) for a broad range of call types.

To develop algorithm metrics the expert committee will consider existing standards such as the Detection Error Tradeoff curve that examines the two main error types, missed detections and false alarms, as well as Receiver Operating Characteristics curves that compare correct detections to false alarms. Alternative methods for algorithm assessment will also be considered.

THE SCHEDULE

The first year of the project will be spent analyzing data recorded at naval training ranges along the West Coast. Later years will examine data from the East Coast and Central/Western Pacific. After each of these databases have been constructed, the team will develop algorithms. A parallel effort will engage the marine mammal detection and classification community to develop a standardized set of metrics. The first year will focus on metrics for baleen whale calls. Later years will consider odontocete (toothed whale) signals. They will then apply these metrics to both existing and new automatic detection algorithms for specific baleen whale calls and odontocete signals.

NAVY BENEFITS

An expensive aspect of PAM is the personnel cost associated with processing large volumes of data. Automated methods to detect and classify marine mammal sounds could potentially reduce the costs for data processing. By constructing marine mammal sound datasets specific to each naval training area, the project team will facilitate the development and testing of new algorithms for call detection and classification which should lead toward an automated detection system.

TRANSITION

New algorithms can be promulgated once they have been demonstrated to provide the necessary accuracy for a particular species' calls. First Navy users include Navy marine species monitoring program participants. Along these lines, the project team proposes to widely advertise the availability of these datasets for community use in advancing the understanding of acoustic methods to detect, classify, locate, track, count, and monitor marine mammals in their natural environment. Providing these common data sets to the community will allow researchers to directly compare algorithms and methodologies to judge their capabilities.

For more information about this project, visit www.cetus.ucsd.edu.

ABOUT THE PRINCIPAL INVESTIGATOR

John Hildebrand has served as Professor of Oceanography at the Scripps Institution of Oceanography since 1995. He holds a Ph.D. in Applied Physics from Stanford University and a bachelor's degree in Physics and Electrical Engineering from the University of California, San Diego.

About the LMR Program

The Living Marine Resources (LMR) program seeks to develop, demonstrate, and assess data and technology solutions to protect living marine resources by minimizing the environmental risks of Navy at-sea training and testing activities while preserving core Navy readiness capabilities. For more information, contact the LMR program manager at exwc_lmr_program@navy.mil or visit www.lmr.navy.mil.