



LIVING MARINE RESOURCES PROJECT 8

Improving the Navy's Automated Methods for Passive Underwater Acoustic Monitoring of Marine Mammals

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.

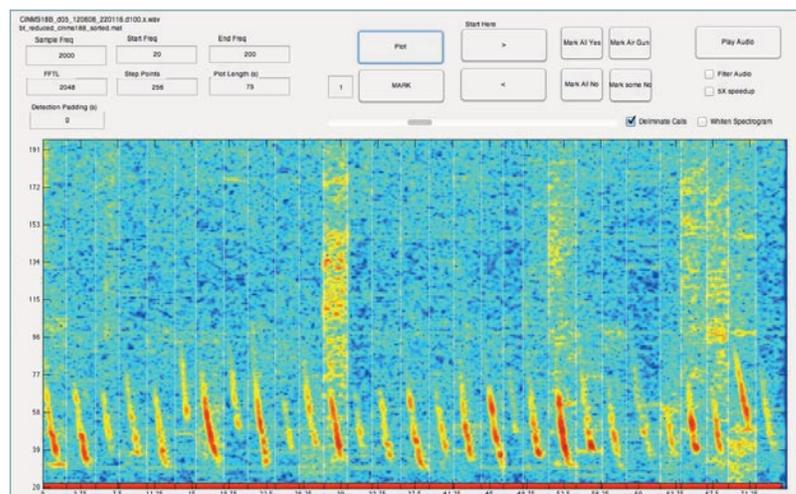
THE SOLUTION

The sonar/radar signal processing community has derived approaches for developing optimal detectors for signals of interest. The objective of this project is to take the methods and approaches developed for active and passive sonar and apply them to the Navy's PAM of marine mammal populations.

Principal Investigator Helble (along with Gerald D'Spain) developed the Generalized Power Law (GPL) processor with resources provided by the Office of Naval Research. This processor is considered the optimal detector for transient signals, in the situation where the signal has an unknown frequency content, location, duration, and strength. This GPL processor has been used extensively with great success in humpback whale data collection by the autonomous High-frequency Acoustic Recording Pack-

ages (HARP) that are currently being used for PAM at several Navy testing and training ranges.

Although the theoretical foundation for the development of optimal and near-optimal detectors is well established, an "art" still exists with the development of practical detectors for use with real data. For example, background noise in the ocean is never static or "white." Any algorithms developed for GPL processing are constrained by the need for pre-processing adaptation to accommodate the local noise environment as well as onboard factors (noise created by the platform itself). In addition, ocean bathymetry greatly influences PAM readings. For these reasons, creation of a fully automated system is not feasible. This project will design a system that "calls out" potential signals of interest for examination by a human operator.



Spectrograms of GPL detections shown in the graphical user interface (GUI) for blue whale "D" calls, often made during foraging activity. The GUI allows the operator to quickly accept/reject detections provided by GPL.

THE METHODOLOGY

Working closely with other LMR-sponsored project teams, this project effort will first adjust GPL algo-

rithms for use with specific marine mammals and then test and implement these algorithms with data from existing PAM systems used for monitoring on Navy ranges. A detector auto-tuning method and a graphical user interface will also be developed so that users of the current GPL system can adapt the system themselves with minimal training. Subsequent to this, detected call counts will be corrected for environmental properties at the recording sites so that the resulting “environmentally calibrated” call count densities can be used for census purposes to assess trends in call densities. Once animal cue rates are better understood, these call densities can be converted into animal density estimates. For study areas that contain multiple hydrophones where localization is possible, the GPL algorithm will be used in combination with localization techniques in order to provide animal track lines in the study area.

THE SCHEDULE

As of mid-2014, the project team has tuned and calibrated the GPL detectors for three species of marine mammals at the Pacific Missile Range Facility (PMRF) in Hawaii and three species from HARP recordings deployed throughout southern California. Whale track lines have also been provided for humpback whales on the PMRF range. The next step will be to provide calibrated call counts for 3 species on the HARP recordings, and whale track lines for three species on the PMRF range. The project will be completed by the end of the Fiscal Year 2016.

NAVY BENEFITS

This project will improve the Navy’s PAM capabilities in two critical areas. First, it will implement robust, automated detectors optimized for specific marine mam-

mal species that will vastly reduce the time and cost for human operators to manually examine a data set. The use of such detectors also provides an objective, quantifiable basis for measuring performance. This effort will also provide the methods for calibrating the detector output call counts for spatially and temporally varying ocean environmental conditions. This is a necessary step in using passive acoustic data for estimating call densities.

TRANSITION

A particular emphasis in this project is placed on creating high quality, detailed, thorough documentation—including technical reports, peer-reviewed publications, and presentations at scientific meetings—for all algorithms, software, and methods developed in this program.

As the team is testing and interfacing with the hydrophone array on the PMRF, they will first transition the technology for use on this range. Subsequently, a determination will be made about which Navy training or testing range and PAM system would be next on the list.

ABOUT THE PRINCIPAL INVESTIGATOR

Since 2004, Tyler Helble has been an engineer at Space and Naval Warfare Systems Center in San Diego working on Autonomous Underwater Vehicle (AUV) systems, passive acoustic monitoring, and signal processing, and whale acoustics. He holds a Ph.D. in Oceanography 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.

