Long-term Sparse Array Localization Feasibility Study Using a SonarPoint System

NEED

Sparse acoustic arrays, in which sensors are distributed over a large area of interest, appear to offer cost effective passive acoustic monitoring (PAM) approaches to detect and localize marine mammals. The Office of Naval Research (ONR) Marine Mammals and Biology program investments have identified multiple promising systems of low–cost, easily deployed arrays for monitoring data collection. The practical utility and benefits of these existing systems for collecting data for Navy marine species monitoring applications now needs to be demonstrated in a Navy-relevant context against other existing technologies and methods.

SOLUTION

This project will assess the functionality and durability of a SonarPoint sparse array for detecting and locating a variety of marine mammal species. The modular SonarPoint acoustic recorder uses time synchronization and a configuration of multiple recorders to detect and locate underwater sound. Project efforts will focus on both validating localization capabilities and establishing methods and guidelines for successful localization strategies.

METHODOLOGY

The project will conduct a series of continuous recording (no duty cycling) deployments designed to explore and validate sparse array configurations. Multiple deployments will test the long-term operation of the recorders and evaluate increasing layers of resolution in the localization capabilities of the Sonar-Point system. The work will demonstrate the practical boundaries of sparse array operation in scale, array density, usable frequency spectrum (sample rate), depth dependency and endurance.

The initial deployment will be a subset of three, week-long moorings that vary in depth and inter-recorder distance. It will focus on how recorder spacing affects localization results and will determine a maximum available recorder spacing. It will measure the distance at which cetacean vocalizations can be detected across all recorders and the effective range of a synchronization pinger. This pinger emits a brief signal at regular intervals to maintain clock synchronization among recorders. Recorder depth locations will test the signal detection and localization capabilities for cetaceans vocalizing at varying depth distances from the recorders. Depth and spacing results will be used to configure recorders for the second deployment. The project team will validate array recordings by using a variety of standard visual and passive acoustic methods to detect, approach and record a variety of species, and determine their positions.

SonarPoint mooring string.
Desert Star Systems

The second deployment is planned to demonstrate the long-term operation of the SonarPoint system and extensively evaluate the localization capabilities for a wide range of cetacean species. Two nested recorder arrays, including an inner array for higher frequency signals and an outer array with greater recorder spacing suitable for lower frequency vocalizations,

will be deployed at 1,000–2,000 meters and continuously record for one full year.

The third and final deployment will use established Naval range hydrophone arrays to validate the SonarPoint system localization capabilities. This deployment also will provide an opportunity to train Naval personnel on the deployment, synchronization with pingers and system retrieval.

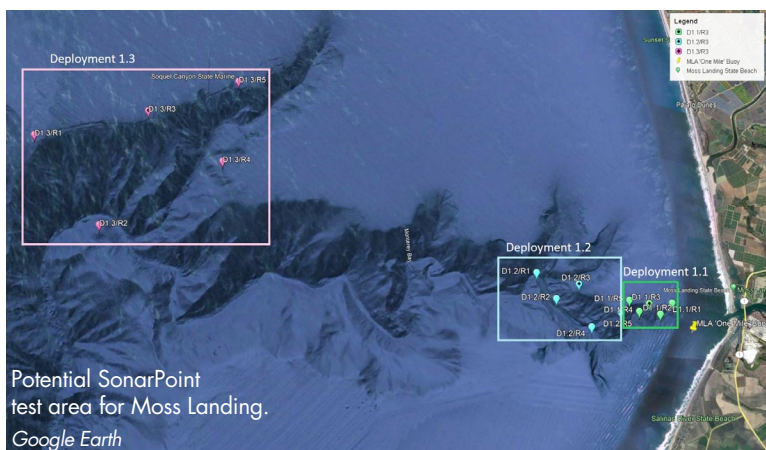Project analyses will use PAMGuard, an open-source passive acoustic software designed to detect and localize marine mammals. PAMGuard (version 2.02.03) will be used both to annotate the dataset for marine mammal calls and to obtain localizations to these acoustic events. PAMGuard capabilities will be augmented by Desert Star-designed experimental software to explore the merits of different approaches to sound source localization.

Potential SonarPoint test area for Moss Landing.
Google Earth

SCHEDULE

The project's first deployment is scheduled for Spring 2023, with subsequent deployments slated during Fall 2023 and 2024. Analyses and reporting will be conducted after each deployment, with a final report completed by Summer 2025.

NAVY BENEFITS

This effort could ultimately support acoustic-based estimates of density, abundance and location of vocalizing marine mammals, specifically in locations beyond established Navy training ranges. The time synchronized recorder array and software capable of handling large acoustic datasets will provide valuable insight into localization capabilities and limitations of a sparse array. Successful use of a sparse array within a monitoring area could provide an effective and lower cost option for Navy's Marine Mammal Monitoring Program to monitor vocally active marine mammal species.

TRANSITION

Project findings will be presented in a final report, accompanied by analytical results and full acoustic datasets for prospective system users to evaluate. The project will also provide the SonarPoint test system equipment and will produce a SonarPoint Sparse Array User's Guide and software to support system operation, signal detection and localization with SonarPoint.

ABOUT THE PRINCIPAL INVESTIGATOR

Marco Flagg is chief executive officer and principal designer of Desert Star Systems, which manufactures the SonarPoint system. Mr. Flagg's expertise includes acoustic positioning systems, acoustic releases, broadband recorders, acoustic modems and satellite reporting tags. Mr. Flagg and Desert Star Systems emphasize a combination of modular product design and strong field support and experience.

Key contributors: Elizabeth Ferguson, Ocean Science Analytics, and Jeff Jacobsen, independent contractor.

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 exwc.navfac.navy.mil/lmr.