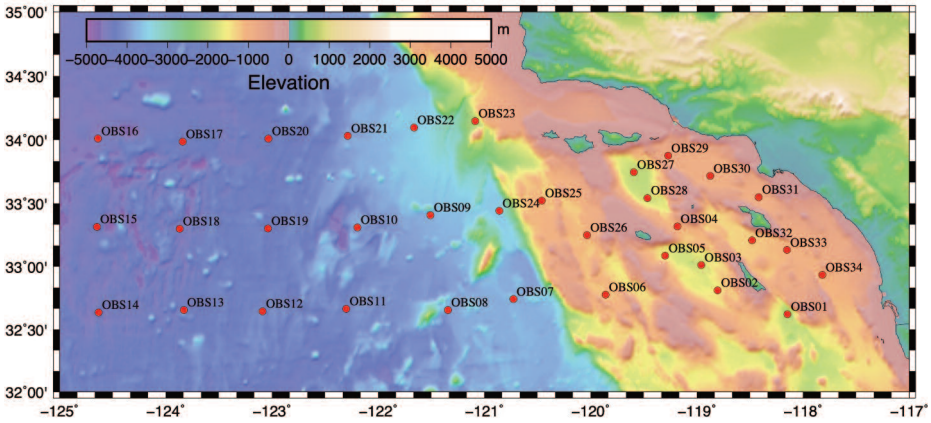
LIVING MARINE RESOURCES PROJECT 49

Combining Global OBS and CTBTO Recordings to Estimate Abundance and Density of Fin and Blue Whales

NEED

Marine mammal density estimates are a critical input for the Navy's acoustic effects modeling using the Navy acoustic effect model (NAEMO). Although the ship and aerial visual surveys traditionally used to estimate marine mammal density are viable for the Navy, such surveys are limited in spatial and temporal coverage. The Office of Naval Research Marine Mammals and Biology (ONR MMB) program has developed passive acoustic monitoring (PAM) approaches using sparse arrays in which sensors may be distributed evenly but widely over a large area of interest. These are often referred to as 'platforms of opportunity' when their primary monitoring purpose is not for marine mammals. Examples include Ocean Bottom Seismometers (OBS) and Comprehensive Nuclear Test Ban Treaty Organization International Monitoring System (CTBTO IMS) recorders. Density estimation methods have been applied to a few case studies using both OBS and CTBTO IMS data containing fin and blue whale calls. While these studies have demonstrated the utility of OBS and CTBTO IMS data, the techniques to estimate range to calling animals and to estimate density still need to be compared and validated under different conditions to be able to fully utilize the worldwide data sets.



Map showing an example of an Ocean Bottom Seismometer array deployed for the Albacore seismic experiment off the coast of Southern California, August 2010–September 2011.

SOLUTION

This project is working to demonstrate and refine a suite of methods previously developed to obtain density estimates across a variety of OBS and CTBTO IMS deployments. The data used will reflect a variety of instrument configurations and acoustic propagation conditions. The suite of density estimation methods demonstrated for both OBS and CTBTO IMS data will provide the framework for a set of software tools and training materials to enable a wide range of stakeholders to estimate blue and fin whale density from OBS and CTBTO IMS data and other similar instrumentation.

METHODOLOGY

This work will be co-funded by LMR and ONR MMB and will build on information compiled under previous ONR MMB funding. The ONR MMB funded portion of the effort includes reviewing existing OBS and CTBTO IMS data sets around the world, selecting a set of case study data sets containing blue whale and/or fin whale calls, comparing ranging methods, evaluating results and developing methods for density estimation. Varying conditions such as spatial configuration, hardware specifications and oceanographic settings of different arrays will dictate which signal processing methods, and therefore density estimation methods, can be applied to a given data set.

The first part of the LMR funded portion of the project will focus on signal processing of the OBS and CTBTO IMS case study data sets and implementing the density estimation methods developed under ONR funding. An additional task under this phase will include analyzing the case study data sets to explore various ecological and behavioral questions at a range of scales, from analyzing fine scale tracks of calling whales, to assessing largescale spatial and temporal patterns of animal vocal activity.

The project team will then focus on documenting the research software and case study data sets and developing training materials. The team will configure the software developed during the project so that the different code modules and data formats work together. This includes ensuring that the code for each ranging method produces outputs that are formatted for use with the density estimation algorithms (typically written in R, a free statistical software package).

Training materials will combine the various algorithms and will include developing a flow chart to help users in different geographic areas produce density estimates from their OBS or CTBTO-IMS instruments. These training materials will contain extensive documentation and examples. This will provide the basis for future work to incorporate these techniques into a single user-friendly package.

SCHEDULE

The project will begin with the ONR MMB-funded task of comparing ranging methods, with sub-tasks continuing into 2024. LMR tasks to estimate density for case study data sets will be initiated in early 2022 and continue into 2025. Documentation and training materials will be completed by the project's conclusion in mid-2025.

NAVY BENEFITS

The techniques being demonstrated through this project will potentially make available extensive data sets reflecting large geographic areas at relatively low cost. This work will facilitate the use of both OBS and CTBTO-IMS data by (a) synthesizing and refining existing ranging and density estimation methods for these platforms and (b) creating guidance documents and tools for the Navy and other stakeholders to use.

TRANSITION

Project results will be shared through peer-reviewed publications and conference presentations. Final products will include software tools and training materials.

ABOUT THE PRINCIPAL INVESTIGATOR

Danielle Harris is a senior research fellow at the Centre for Research into Ecological and Environmental Modelling at the University of St Andrews, where she earned her Ph.D. in biology and statistics. Dr. Harris' research focuses on using acoustic data to monitor wildlife populations, in particular developing methods to estimate the density and abundance of marine mammal species.

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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.navfac.navy.mil/lmr.