



LIVING MARINE RESOURCES PROJECT 81

Continuously Active Sonar—Responses via Ecologically-based Documentation of Perturbation

NEED

Results from previous behavioral response studies have indicated that both the type and the duration of Navy sonar signals may play a role in observed responses in marine mammals. As sonar technologies change, the Navy needs new information on the effects of new types of sonar on marine mammal hearing and behavior. Continuous active sonar (CAS) is a type that can operate at lower energy levels than traditional pulsed signals, but operates at higher duty cycles (i.e., transmits for a longer time). With increased CAS use in training, the Navy needs more information to further understand the effects of CAS on marine mammals, particularly with additional marine mammal species.

SOLUTION

This project is undertaking a thorough investigation into how anthropogenic sounds influence whale behavior, with a particular focus on beaked whales (*Ziphius cavirostris*) and the newer CAS systems that are increasingly used in anti-submarine warfare training within the Southern California Tactical Training Range. The growing sample of high-resolution data coming from Sound and Motion Recording and Transmitting (SMRT) tag deployments, which have captured a wide range of anthropogenic sounds that occur during training, and the long datasets from the Southern California can provide more refined insights into animal responses.

METHODOLOGY

The project team will leverage past and ongoing SMRT tag deployments, as well as other available data with pulsed active sonar (PAS) and other signals, to analyze cetacean responses to CAS and other sound sources. Efforts will focus on analysis, including support for additional data processing, model development and capacity building.



Goose-beaked whale
(*Ziphius cavirostris*).
Gregory S. Schorr, permit 16111

Primary analyses will evaluate two key questions:

1. Will exposure to CAS result in identifiable changes in diving and vocal behavior of individual tagged whales?
2. Will responses to CAS differ from responses to PAS in similar exposure contexts (e.g., maximum received level, cumulative sound exposure level, bout duration, distance to source)?

Initial work will focus on two main areas: 1) adapt and apply existing statistical methods and tools to handle and share big, high-resolution biologging datasets; and 2) develop and apply state-based models of animal behavior to quantify how beaked whales, fin whales and dolphins alter behavior in response to several types of underwater sounds associated with Naval training operations, using both tag and passive acoustic data sources.

The analyses will begin by using a Hierarchical Hidden Markov Model (HHMM) to integrate large samples of multi-scale data across individuals. Previous development of this approach has resulted in a robust, flexible statistical path forward for exposure data provided by the SMRT tags. This project will move the method toward completion and then document it and train other analysts in its use. This would enable this method to be applied to response work in other regions or with other species.

As the tools are refined and validated with beaked whales, the team will shift analyses to other species whose less-stereotyped behavior may present new analytical challenges. These may require additional data collection and model development to yield publishable results.

When the team has adequate samples of exposures to both PAS and CAS to address the main questions using the HHMM, they will move to publish those results. New tools and product outputs for the SMRT tags will be added to the existing GitHub site, providing the tools to other end-users of the SMRT tags.

SCHEDULE

The project started in 2025 and has a target completion by the end of 2028. Early efforts will focus on the analytical tool refinement and application, leading to training and broader application.

NAVY BENEFITS

This project will leverage the Navy's prior investments in high-resolution data collection during both past and concurrent field work and provide more detailed analyses than previously completed. Results of this effort will support direct comparison between responses to CAS signals and to conventional, lower duty-cycle MFAS signals. The results will be applicable to other *Ziphius* populations subject to response studies and will provide data to inform the acoustic thresholds used in criteria development.

PRODUCT AND DELIVERABLES

The primary products of this project will be peer-reviewed publications and data to support criteria and threshold development. It will also provide publicly

available tools and methods for processing extended, high-resolution tag data that include exposure to signals of interest.

ABOUT THE PRINCIPAL INVESTIGATORS

Greg Schorr, a research biologist at the Foundation for Marine Ecology and Telemetry Research, has been studying marine mammals for over two decades. His most recent focus has been using a variety of tag types to study beaked whale ecology and behavioral responses to anthropogenic sources of sound.



Erin Falcone, a research biologist at the Foundation for Marine Ecology and Telemetry Research, is a cetacean photo-ID and tagging specialist. She has been a principal investigator of marine mammal studies at the Southern California Offshore Range since 2006.



Stacy DeRuiter is an assistant professor at Calvin University where she teaches statistics and conducts applied statistics research. Her work includes statistical method development and applications, especially for dependent multivariate time-series. She earned her Ph.D. in biological oceanography from the Massachusetts Institute of Technology and Woods Hole Oceanographic Institution joint program.



About the LMR Program

The LMR program's fundamental mission is to support the Navy's ability to conduct uninterrupted training and testing, which preserves core Navy readiness capabilities. LMR is an applied research program that funds Navy-driven research needs to support at-sea compliance and permitting. For more information, contact the LMR program manager at exwc_lmr_program@us.navy.mil or visit exwc.navfac.navy.mil/lmr.

