LIVING MARINE RESOURCES PROJECT 64

3S4—Effect of Continuous Active Sonar and Longer Duration Sonar Exposures

NEED

It has been observed from previous behavioral response studies that signal type and duration of Navy sonar signals may play a role in observed responses in marine mammals. In 2017, LMR began investing in studying and collecting behavioral response data to continuous active sonar as part of the third phase of the Sea Mammals and Sonar Safety (3S3) project (LMR Project 29). However, there is an expanded need to further understand the effects of continuous active sonar on marine mammal hearing and behavioral response, particularly with additional marine mammal species.

Applying a tag to a whale.
Jacqueline Bort Thornton

SOLUTION

The 3S project is part of a broader international research consortium that has been conducting behavioral response studies on six different cetacean species in North Atlantic waters since 2006.

The objectives of phase four of the 3S project (3S4) are to:

1. Investigate whether exposure to continuous active sonar (CAS) leads to different types or severity of behavioral responses than exposure to traditional pulsed signals (PAS) in killer whales, humpback whales and bottlenose whales.
2. Investigate if responses from short duration experiments predict responses from longer duration exposures conducted over an operationally relevant duration.

Of particular interest are species that: 1) vocalize in the frequency band of the sonar (e.g., killer whales and humpback whales), because CAS has higher potential for masking, and 2) have been shown to be particularly sensitive to PAS (e.g., beaked whales).

The project is supported in partnership with the LMR program and Canadian, French, Norwegian, Icelandic and Dutch naval authorities and research organizations. Coordinating with this international effort will help both the U.S. Navy and allies in the North Atlantic Treaty Organization (NATO).

METHODOLOGY

The objectives of the project will be achieved by doing short- and long-duration CAS and PAS exposures using real-time GPS location data of multiple tagged subjects. Suction-cup attached Mixed DTAG+ and DTAG3+ units will include a DTAG3 core unit, VHF transmitter and the new GPS-ARGOS unit built by Lotek. The source vessel will be equipped with a Goniometer-receiving system for real time reception of ARGOS transmissions, and with the decoding

system for GPS location data. For longer term tracking, satellite tags (SPLASH10-F-333B) will be deployed early in the trials to collect information on animal movement over a longer timeframe (2–3 month expected tag duration).

The project team will collect data on animal responses to CAS and PAS, with killer and humpback whales as the target species. These species are found in large numbers on the herring overwintering grounds off northern Norway. Previous behavioral studies have shown that these species avoid the sonar source and cease foraging during exposure. However, humpback whales rapidly resume foraging, while killer whales appear to have more prolonged responses.

The data analyses will include quantitative (state-based modeling of behavior and Mahalanobis distance) and qualitative (severity scoring) analysis of data recorded by the animal-attached tag. The key goals of the data analysis will be to quantify the magnitude/severity of observed behavioral changes during the sonar treatments, compared to the pre-exposure baseline period.

Sperm whale tagging. Occasionally a whale will be double-tagged in case one tag falls off too early.

Saana Isojunno

For objective 1, response patterns during CAS experiments will be compared to those observed during PAS experiments. The team will use a 1–2 kHz signal during short duration exposures, which are typically conducted over 30–40 minutes and involve a single dose escalation design. This experiment focuses on the difference in duty cycle of the signal (CAS vs. PAS). Since both of the target species produce communication signals in the frequency range that overlaps with the source signal, masking will be a core part of the effects analysis. Detailed acoustic and behavioral analyses will evaluate pre-defined indicators of masking for each species. The behavioral analysis of masking will be supported by a theoretical analysis of masking potential during the experiments.

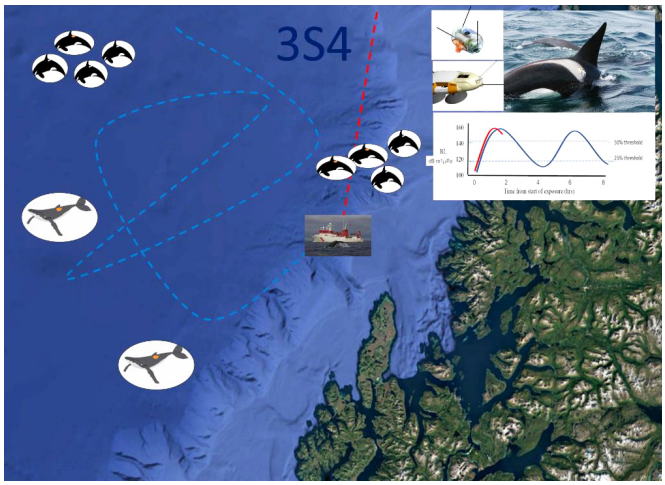
For objective 2, the key goal will be to determine the influence of duration during the longer 8-hour sonar exposure sessions, which get closer to the duration of most operational scenarios. This experiment will require the source vessel to move to achieve repeated dose escalations above the level at which 50% of subjects are expected to respond. The results will be compared to the shorter duration exposures conducted under objective 1.

SCHEDULE

Two four-week long field efforts, for tagging and CAS exposure, will be conducted, one in 2023 and one in 2024. Initial data analyses and results will be completed following each field effort with final products expected by the close of 2026. A third field season might be conducted in 2025, depending on agreements among sponsors.

NAVY BENEFITS

Current environmental compliance assessments for Navy sonar are based on traditional PAS technologies. With the higher duty cycle of the new CAS technologies, the Navy needs more information on how multiple species respond to CAS compared to PAS. Furthermore, the longer duration exposures up to eight hours will provide data that are more relevant to operational scenarios. This project will provide valuable data to support new assessments.



The objectives of the 3S4 project will be achieved by doing short- and long-duration CAS and PAS exposures using real-time GPS location data of multiple tagged subjects. The source will be moved to achieve repeated dose escalations over 8 hours and responses to the first approach will be compared to subsequent approaches.

TRANSITION

Results will be shared in published cruise reports, project data reports and peer reviewed papers. Presentations to naval sponsors will be conducted twice each year, in addition to the annual presentation to the LMR In-progress Review. End users include the U.S. Navy environmental compliance community, naval officers of the sponsoring NATO navies and the scientific community.

ABOUT THE PRINCIPAL INVESTIGATOR

Frans-Peter Lam, the lead principal investigator, is a senior scientist at The Netherlands Organization for Applied Scientific Research (TNO). Dr. Lam earned his Ph.D. in physics and astronomy from Utrecht University in The Netherlands. His main research interests are the effects of sound on marine mammals and military oceanography.

Co-investigators: Petter Kvadsheim (FFI (Norwegian Defence Research Establishment)), Patrick Miller, Peter Tyack and Saana Isojunno (University of St Andrews Sea Mammal Research Unit), Charlotte Curé (CEREMA (Centre for Studies and Expertise on Risks, the Environment, Mobility and Urban Planning, France)), Paul Wensveen and Filipa Samara (University of Iceland), Sander von Benda-Beckmann (TNO).

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.