



LIVING MARINE RESOURCES PROJECT 29

3S3: Behavioral Responses of Cetaceans to Naval Sonar

NEED

The Navy is responsible for compliance with a suite of Federal environmental laws and regulations, including the Endangered Species Act (ESA) and the Marine Mammal Protection Act (MMPA), that apply to marine protected species. As part of the regulatory compliance process associated with these acts, the Navy is responsible for assessing potential impacts from Fleet and Systems Command military readiness activities involving active sonar and the use of explosives and explosive munitions.

To meet regulatory requirements, the Navy needs direct, empirical information about how protected marine species respond to sound exposures. The Navy's Living Marine Resources (LMR) program funds applied research to gain vital information about marine mammal species, including their behavioral responses to sound. The Southern California Behavioral Response Study (LMR Project 2) is one example of efforts on the U.S. Navy's Southern California ranges to study responses to mid-frequency active sonar (MFAS).

While this research provided valuable information on marine mammal responses, it also raised new questions related to sonar sources, sonar types, duty cycle (the ratio of transmission time and repetition time), and the importance of distance between sources and animals. In particular, the research so far has focused on the traditional pulsed active sonar (PAS). (Also referred to as intermittent sonar by the U.S. Navy.) However, new sonar technologies also involve the use of continuously active sonar (CAS). The Navy needs new information about how marine species respond to CAS.



For smaller, faster species like the pilot whale, a hand-held pole is used to deploy the DTAGs.

Rune Roland Hansen, permitted by the Norwegian Animal Research Authority (Mattilsynet), permit 2015/223222

SOLUTION

The 3S (Sea mammals, Sonar, Safety) 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 with since 2006. The current (third) phase of the 3S project (3S3) is evaluating whether exposure to CAS leads to different types or severity of behavioral responses than exposure to traditional PAS (intermittent) signals. The project also is evaluating how the distance to the source affects behavioral responses. The project is being funded in partnership with the LMR program and the United Kingdom, French, Norwegian and Dutch naval authorities. Coordinating with this international effort will help both the U.S. Navy and allies in the North Atlantic Treaty Organization (NATO).

METHODOLOGY

This phase of the 3S-project is focused on addressing two separate questions in parallel using the same experimental design:

1. Does exposure to CAS lead to different types or severity of behavioral responses than exposure to traditional PAS signals, or does the CAS feature of high duty cycle lead to acoustic responses that indicate masking?
2. How does the distance to the source affect behavioral responses?

Field efforts are conducted in Norwegian waters along Norway's northern coast. The primary focus animals are sperm whales (*Physeter macrocephalus*), but the team also works with pilot whales (*Globicephala melas*) and killer whales (*Orcinus orca*) when sperm whales are not available.

The project employs controlled sonar exposure experiments (CEE). The research team uses visual observers and acoustic arrays to locate whales of interest. When animals are located, a digital acoustic monitoring tag (DTAG), in this case DTAG3 or a mixed-DTAG, is attached by non-invasive suction cups to each animal that can be approached. The sensor package of the mixed-DTAG adds a GPS logger and satellite transmitter to the DTAG3 sensor package. The tags are programmed to release after 15–17 hours.

After establishing baseline behavior characteristics of each tagged whale, and ensuring all protection measures are in place, the team initiates the experimental phase, the CEE. The team uses the SOCRATES source, which was developed at The Netherlands Organization for Applied Scientific Research (TNO) and is used as an experimental system within the Netherlands Navy. The maximum source level is somewhat lower than most operational low-frequency active sonar systems. Each tagged subject is exposed to both CAS and PAS as well as a no-sonar control experiment. Well established analytical approaches to contrast the effects of range and CAS versus PAS will be employed during data analysis.

SCHEDULE

During the 2017 field season, conducted during late June to mid-July 2017, the team successfully deployed DTAG3s or mixed-DTAGs on 11 sperm whales and two pilot whales to record vocal, movement and dive behavior. Fifty-six hours of baseline behavioral data were collected on sperm whales and seven sonar controlled exposure experiments were conducted. Baseline data also were collected from pilot whales. Analysis of data will continue into 2018.

In addition, there is an optional portion of this project that will include using a Norwegian Navy frigate to conduct CEEs in 2019. This work would focus on using the frigate to transmit sonar at higher source levels, but achieve the same exposure levels at much longer distances. This would supplement the data set on the effect of range, and allow investigation into whether the effect of range is more important at relatively long distances. Planning and coordination will occur in 2018 to determine if this option is feasible.



The tag crew practicing the use of the tag pole in the fjords of Norway before heading out to sea.

Rune Roland Hansen



The towed hydrophone array, nicknamed Delphinus, was developed by TNO for the detection and classification of marine mammal vocalizations, as well as to localize marine mammals in real time.

Martijn van Riet

NAVY BENEFITS

The collection of data on how marine mammals respond to CAS and PAS, in addition to distance from the source, will continue to improve the assessment of behavioral response. The direct data on actual behavioral responses in controlled conditions with free-ranging cetaceans will be applied to the environmental impact assessments the Navy prepares for training and testing permit applications and other legal requirements. The results will allow the Navy to improve impact assessments and better estimate the potential effects of sonar use on marine mammals.

TRANSITION

Study results will be published in the peer-reviewed scientific literature and presented at technical meetings. Data sets will support empirical risk function

development for the Navy's at-sea environmental compliance efforts. The outcomes will not only inform legal requirements but also broaden the scientific and public understanding of marine mammal behavior.

ABOUT THE PRINCIPAL INVESTIGATORS

Frans-Peter Lam, the lead principal investigator (PI), is a senior scientist at The Netherlands Organization for Applied Scientific Research. 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.



Petter Kvadsheim, co-PI, is a principle scientist and program manager with FFI (Norwegian Defence Research Establishment). Dr. Kvadsheim earned his Ph.D. in zoophysiology from the University of Tromsø, Norway.



Patrick Miller, co-PI, is a senior research fellow at the Sea Mammal Research Unit and professor in the School of Biology, University of St Andrews, Scotland. Professor Miller earned his Ph.D. in biological oceanography from the Woods Hole Oceanographic Institution/Massachusetts Institute of Technology joint program.

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 <http://greenfleet.dodlive.mil/lmr>.

