Collection of Auditory Evoked Potential Hearing Thresholds in Minke Whales

Need

There is a need to improve understanding and measurement of auditory capabilities and sensitivities of low-frequency cetaceans (mysticetes) to anthropogenic sound. Research necessary to generate a mysticete audiogram includes developing and validating finite element modeling (FEM) methods, developing and testing in-situ auditory evoked potential (AEP) measurement methods for mid- and high-frequency hearing sensitivities of mysticetes, developing tools for AEP measurements below 1 kHz, evaluating behavioral response methods and identifying other appropriate approaches or methods.

Solution

This project addresses the portion of the need related to using in-situ AEP measurements of the hearing sensitivity of mysticetes. AEP methods involve measuring small voltages that the brain and auditory nervous system generate in response to sound. Using AEPs to determine hearing sensitivity has been common practice in human and terrestrial animal research for decades. Over the last two decades, the technology also has been used routinely to test hearing in odontocetes both small (e.g., dolphins and porpoises) and large (e.g., beluga, pilot and killer whales). The project team, led by Dr. Dorian Houser, proposes to obtain AEP hearing thresholds for minke whales (*Balaenoptera acutorostrata*), which will provide the first direct measurement of hearing in a mysticete.

Methodology

The project team is proposing to capture minke whales off the Norwegian coast to measure their hearing using AEP methods specifically modified for these animals. The research plan focuses on small (3–5 meters long) juvenile minke whales, because they are more suitable for handling and should have good hearing capabilities. Juvenile minke whales are similar in size to wild beluga whales that have been previously captured for AEP testing. The project goal is to conduct AEP hearing tests on 12 healthy animals deemed fit for testing by a marine mammal veterinarian at the time of initial capture.

It is anticipated that the modifications to AEP methods will largely consist of adapting approaches previously worked out on smaller cetaceans with a special focus on sound delivery and AEP recording at lower frequencies. Researchers will use both broadband and narrowband acoustic stimuli to optimize procedures and determine

Minke whale.

the shape of the minke audiogram. Upon conclusion of testing, each whale will be fitted with a satellite tag to monitor its behavior after release.

All necessary permits are in place and the project was approved by the National Marine Mammal Foundation (NMMF) Institutional Animal Care and Use Committee (IACUC). In addition, a Department of Defense (DoD) veterinarian has reviewed and approved a Bureau of Medicine and Surgery (BUMED) animal use protocol in compliance with the DoD Instruction, "Use of Animals in DoD Conducted and Supported Research and Training." A safety protocol has been developed to ensure the health and safety of the animals and researchers during the entire effort.

Schedule

The project is effectively a two-phased project with a go/no-go decision by the sponsors between phases. Efforts in the first phase (2019–2021) will include planning for and conducting one full field season. Based on the results of the first field season, the research team will present findings and recommendations to the funding agencies to determine if work will continue.

The second phase (2022–2024), if approved, will focus on refining methods and conducting additional field seasons to collect data. Each year within the second phase, the sponsors will review results and determine whether work should continue.

Benefits

The results of this study will be invaluable to regulators, scientists and action proponents concerned with the potential impact of sound on mysticetes. Determining frequency-specific information, particularly the upper-frequency limit of hearing and the region of best sensitivity, will provide data needed for validating models of hearing in mysticete whales. Additionally, determining low-frequency thresholds will provide information needed to establish auditory weighting functions for mysticetes, which currently lack empirical data. Techniques developed during the minke whale hearing tests also will facilitate future audiometric measurements on other mysticete species (e.g., during stranding events and live-capture studies).

Data will be made available through peer-reviewed publications and incorporated into a central repository of marine mammal evoked potential hearing data (The Cetacean Evoked Potential Audiometry Database). Methods developed for testing of mysticete hearing will be described in peer-reviewed publications and will be used to train stranding personnel that could have the opportunity for further testing with stranded mysticetes.

About the Principal Investigator

Dorian Houser is the Director of Biologic and Bioacoustic Research at the National Marine Mammal Foundation (NMMF). Dr. Houser has spent nearly two decades in the study of how anthropogenic sound affects marine mammals and has been involved in the development of numerous environmental impact statements for the U.S. government. He earned his Ph.D. in Biology from the University of California, Santa Cruz.

Co-PIs are Jason Mulsow, PhD (NMMF), Petter Kvadsheim, PhD (Norwegian Defence Research Establishment (FFI)), Lars Kleivane, MSc (LKARTS Norway), James Finneran, PhD (US Navy Marine Mammal Program (MMP)) and Rolf Arne Ølberg, DVSc (Kristiansand Dyrepark).

The Subcommittee on Ocean Science and Technology (SOST) authorized establishment of an Interagency Task Force on Ocean Noise and Marine Life (ITF-ONML). A subset of the ITF-ONML's member agencies partnered to jointly fund research on the auditory capabilities of mysticetes. This project is one of three projects that was selected for funding. Each project was funded by various agency partners.