LIVING MARINE RESOURCES PROJECT 22

Hearing and Estimated Acoustic Impacts in Three Species of Auk: Implications for the Marbled Murrelet

NEED

The Navy is responsible for compliance with a suite of Federal environmental laws and regulations that apply to marine protected species, including the Endangered Species Act (ESA). As part of the regulatory compliance process associated with these acts, the Navy is responsible for implementing a marine species monitoring program to assess potential impacts from Fleet and Systems Command military readiness activities involving active sonar and the use of explosives and explosive munitions. Some of these activities occur in areas that overlap with the natural habitat of the marbled murrelet (*Brachyramphus marmoratus*), a member of the Auk family that is listed as threatened under ESA in Washington, Oregon and California, and state-listed as endangered in California. Sound, both in-air and underwater, has the potential to affect marbled murrelets in Navy training and testing areas. Potential effects from sound might include auditory impacts such as temporary and permanent hearing threshold shifts as well as non-physical behavioral effects.

Currently there are no basic data on the hearing of marbled murrelets or any other Auk species, thus limiting predictions of the frequencies or sound levels that would actually induce effects. Lacking the information needed to predict with any certainty the appropriate criteria for evaluating the onset of behavioral response or injury in the marbled murrelet, the U.S. Navy has had to use criteria for other species as a surrogate to predict effects.

SOLUTION

This project will define the hearing of up to three Auk species—related to but not including the marbled murrelet—to provide data needed to predict the marbled murrelet's hearing. Efforts will include comparative in-air physiological and behavioral audiometry tests to outline the frequencies and sound levels to be used in the underwater tests, as well as to help ground-truth the underwater data and address potential Auk underwater auditory adaptations. The resulting audiograms will provide the data and training foundation for a temporary threshold shift (TTS) response feasibility study.

Common guillemots (*Uria aalge*) at their colony in Langanes, Iceland. This is one of the species of Alcidae that Mooney and colleagues may examine in hearing studies.

METHODOLOGY

This study will include both auditory evoked potential (AEP) methods and behavioral audiometry methods to study hearing in Auk species. Because Auk hearing has never been studied before, the team will conduct initial field-based, physiological AEP hearing tests prior to the behavioral tests. The field-based AEP tests—widely used, non-invasive, rapid hearing test methods—involve measuring small voltages that the brain and auditory nervous system generate in response to sound. These tests will provide much needed hearing data on several Auk species. The marbled murrelet

itself, due to its protected status, will not be used during testing. However, results from three closely related species of Auks are expected to provide reliable surrogates.

An Atlantic puffin (*Fratercula arctica*) at a colony in Northeastern Iceland.

Following the field-based AEPs, laboratory behavioral audiometry tests will focus on one to three closely related Auk species. These tests involve animals trained to perform a specific behavior in response to sound. The tests will begin with the in-air behavioral audiometry tests, followed by the underwater behavioral audiometry tests. The project team will then compare physiological and behavioral methods, and underwater vs. air results to evaluate the best means to quantify Auk hearing.

In addition to AEP and behavioral audiometry testing, the team also will pursue anatomical testing as available. The goal is to define more clearly the similarities and any potential differences between the target species studied and that of the marbled murrelet.

An initial TTS feasibility study with one species of Auk is also planned to understand more regarding the levels and sounds that may induce TTS and auditory impacts in Auks.

SCHEDULE

The initial field-based, physiological AEP hearing tests will be conducted during a summer 2017 field season. Additional 2017 efforts will include AEP analyses, CT scans and anatomical analyses, in-air behavioral audiometry tests and data analyses, and reporting.

During 2018 efforts will focus on underwater behavioral audiometry tests and associated analysis and reporting tasks. The primary efforts in 2019 will be the TTS feasibility study and publishing results from the overall study. Contingent on feasibility study results, detailed TTS experiments might occur during 2020.

NAVY BENEFITS

These basic data will provide both key hearing data needed for defining acoustic criteria for the marbled murrelet and refine the Navy's assessment of potential impacts from training and testing activities.

TRANSITION

Hearing data sets to support empirical risk function development for Navy compliance efforts will be shared with Navy planners, regulators and other stakeholders through presentations and publications.

ABOUT THE PRINCIPAL INVESTIGATOR

Aran Mooney is an Associate Scientist in the Biology Department at the Woods Hole Oceanographic Institution, where he leads the Sensory Ecology and Bioacoustics Laboratory. His research addresses how marine animals detect and use sound and how animals maybe be affected by anthropogenic noise. Dr. Mooney holds a Ph.D. in zoology (marine biology emphasis) from the University of Hawaii.

Key collaborators include Marianne Rasmussen from the University of Iceland and Magnus Wahlberg from the University of Southern Denmark.

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.lmr.navy.mil.