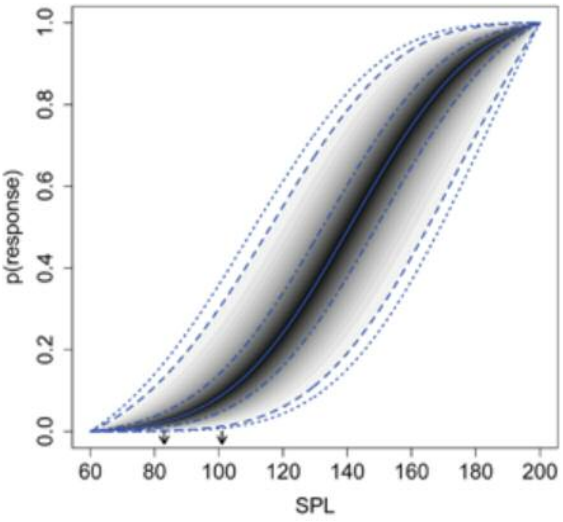
LIVING MARINE RESOURCES PROJECT 36

Analytical Methods to Support the Development of Noise Exposure Criteria for Behavioral Response

NEED

Results from previous behavioral response studies indicate that the context in which marine mammals experience exposure to acoustic sources could affect their response. In particular, the Navy needs information on how the range (distance) of the sound source to the animal may affect behavioral response. Behavioral response data from a variety of operational Navy sources such as hull-mounted sonar, dipping sonar and other types are needed. The Navy needs improved behavioral response data in order to update risk threshold criteria and reduce the uncertainty of the current impact assessments.



An example of a Bayesian dose-response function developed during the ONR-funded MOCHA project.

Figure taken from Miller, P.J.O. et al. 2014. Dose-response relationships for the onset of avoidance of sonar by free-ranging killer whales. Journal of the Acoustical Society of America 135: 975-993.

SOLUTION

Criteria for estimating effects of anthropogenic sound on marine mammal species currently are established for species groups based on functional hearing characteristics. Results of various behavioral response studies (BRS) suggest that these groupings might not be sufficient for predicting response to sonar. To expand the utility of data collected from BRS and to improve the approach to grouping species for exposure criteria, the Navy needs additional, more efficient modeling methods for estimating responses of multiple species.

This project is focused on developing a computationally efficient model selection method that supports and expands upon the existing Bayesian hierarchical dose-response framework that has been and continues to be employed. The model selection method will seek to enable many more species and covariates (e.g., signal type, whale-source range, received exposure level, animal behavior at time of exposure, etc.) to be included in the model. The overall goal is to develop an objective, data-driven methodology for selecting species groupings, relevant covariates and dose metrics, and appropriate functional forms for the dose response function in support of noise exposure criteria.

METHODOLOGY

The project team will build on outcomes of the ONR-funded MOCHA (Multi-study Ocean Acoustics Human Effects Analysis) project (https://synergy.st-andrews.ac.uk/mocha) to develop a new model selection method. Work will include investigating alternative dose-response functional forms (e.g., biphasic functions), evaluating such functions across species and species groups using model selection methods and investigating survival analysis concepts. The methods will be tested using simulated data and multi-species data compiled during the MOCHA project and newer data. The team will run analyses with a full data-set and align outputs with identified requirements from a data workshop.

The project team will aim to derive exposure-response functions for each selected species group. They also

will evaluate explicitly how contextual covariates contribute to outcomes. A priority dose metric to investigate will be whale-source range because an important need is to understand the relationship between how the range (distance) of the sound source to the animal may affect behavioral response.

SCHEDULE

The bulk of dataset identification, model selection method development and testing, and working with stakeholders will be completed throughout the project's first year. During the second year the team will obtain input on initial results, complete analysis of a full dataset and prepare a final manuscript for publication.

NAVY BENEFITS

Developing a more efficient model selection method will maximize the potential of the existing Bayesian hierarchical dose-response framework. The results will offer species groupings for use by those developing the Navy's Phase IV behavioral risk functions. While the groupings will not be required to be used, they will, at a minimum, provide another piece of evidence to inform the creation of species groupings. The proposed work will also address the need to understand the relationship between responsiveness and dose metrics other than those related to received sound level. The model will use currently available data both to fit a relationship between whale-source range and probability of response and to determine the form of this relationship and the level of variability within and between species. The outcomes will offer guidance on data requirements, data formats, priority covariates and dose metrics to ensure data collected in the future can be utilized in this framework.

TRANSITION

This project's two major outputs—a demonstrated, computationally efficient analytical tool and the model results¬—will be used to refine the Navy's Phase IV behavioral risk functions. Intended end users include the Navy environmental compliance community, the National Marine Fisheries Service regulators, and other federal agencies, as well as the general scientific community.

Code and technical guidance documents for the dose-response model and the model selection method will be made available as appropriate. The general scientific community will be reached through publication of a peer-reviewed manuscript and presentations at relevant meetings/conferences.

ABOUT THE PRINCIPAL INVESTIGATORS

Len Thomas, the current director of the University of St Andrews Centre for Research into Ecological and Environmental Modeling (CREEM), specializes in developing statistical methods to apply to ecological problems, including for analysis of behavioral response specifically for Blainville's beaked whales at AUTEC.

Catriona Harris, a senior research fellow at the University of St Andrews Centre for Research into Ecological and Environmental Modeling (CREEM), has been carrying out research on the impact of anthropogenic noise on marine mammals for 12 years, and specifically behavioral responses of marine mammals to noise, for over seven years. She was Co-PI on the MOCHA project which developed analytical methods for analyzing data from behavioral response studies.

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.