LIVING MARINE RESOURCES PROJECT 75

# Evaluating Population Consequences of Disturbance (PCOD) to Support Navy Compliance Permits

## NEED

To understand how marine species respond to Navy testing and training activities and the effects on marine species populations, it is increasingly important to consider multiple anthropogenic stressors. The Navy's Office of Naval Research Marine Mammal Biology (ONR MMB) program has moved this area of investigation forward through work on Population Consequences of Disturbance (PCOD) models and extending to Population Consequences of Multiple Stressors (PCoMS), which links exposure to multiple stressors and population level effects. The potential effects of multiple stressors on marine mammal populations could influence short- and long-term responses to Navy activities. The Navy needs additional validation data for PCoMS models to support its compliance efforts.

A humpback whale calf tagged with a non-invasive suction cup tri-accelerometer tag in Hawaii. *MMRP, NOAA permit 21476*

## SOLUTION

This project will develop a suite of PCoMS models to evaluate alternative disturbance scenarios and to forecast population consequences of humpback whales. This information will improve understanding of basin-wide humpback whale energetic demands, physiology and reproductive biology in response to oceanographic and anthropogenic stressors. Funding from both ONR MMB and the Living Marine Resources (LMR) programs will enable an ongoing project to expand data collection and forecast modeling to explore oceanographic and anthropogenic stressors on humpback whale health.

## METHODOLOGY

The Marine Mammal Research Program (MMRP) at the University of Hawaii at Mānoa has an extensive dataset of humpback whale body condition measurements, collected in both Hawaiian breeding and Southeast Alaskan feeding grounds. The MMRP team will expand the dataset by collecting additional data in Hawaii throughout the entire breeding season (January through April) over three years. This will maximize the probability of re-sampling individual whales throughout various points of the season. Resamples provide invaluable information on individual rates of change relative to seasonal timing, demographic unit and reproductive status. The team will collect data using unoccupied aerial systems (UAS, aka drones), high-resolution tri-axial accelerometer video tags, and photo identification. Data will include three-dimensional movement patterns, speeds, respiration rates and short-term behavioral responses to anthropogenic stimuli. The Hawaiian breeding ground tag data will provide detailed information on calf suckling rates and quantify behavioral budgets of tagged individuals. Photogrammetry data will be used to estimate body volume.

The team will couple the long-term, multi-year datasets on humpback whale body condition and volume acquisition rates with a suite of oceanographic data on sea surface temperature, salinity, upwelling indices, chlorophyll-a concentration and regional-scale climate data. After creating a comprehensive bioenergetic model for a large baleen whale, the team will then develop a suite of PCoMS models corresponding to alternative disturbance scenarios. This will include linking the response to stressors to vital rates and ultimately population consequences though their effects on body condition and other internal state variables. Efforts will include iterative model validation by comparing model predictions of population health with independent body condition and calving rate observations covering a significant proportion of the population. Model validation and sensitivity analyses will be used throughout the project to identify any specific responses to anthropogenic stressors that require further investigation through experiment. When available, these analyses could include published state-dependent acoustic dose response curves.

This information will contribute greatly towards a better understanding of basin-wide humpback whale energetic demands, physiology and reproductive biology in response to oceanographic and anthropogenic stressors. Using this extensive dataset as a case study for a detailed PCoMS model will help the Navy determine whether it is feasible to assess population level impacts.

## SCHEDULE

The project will include field research efforts in 2025, 2026 and 2027 with analyses conducted following each round of field work. A final analysis year is planned for 2028.

## NAVY BENEFITS

Results will improve understanding of marine mammal responses to multiple stressors and support Navy at-sea compliance efforts.

## DELIVERABLES

Project results will include PCoMS model forecasts of population consequences of human disturbance and will be shared through publications, presentations and status reports. The framework used in this case study will be transferable to other species and other locations where appropriate. These results will be helpful to the Navy at-sea compliance community and the general scientific community.

## ABOUT THE PRINCIPAL INVESTIGATOR

Lars Bejder is the director of the Marine Mammal Research Program (MMRP) at the University of Hawaii at Mānoa. He has studied various aspects of cetacean biology, ecology and conservation, with a focus on developing quantitative methods to analyze behavioral ecology. He serves on the IUCN Cetacean Specialist Group and is a member of the expert panel on Marine Mammal Noise Exposure Criteria. Dr. Bejder earned his Ph.D. at Dalhousie University in Canada.

## About the LMR Program

The LMR program's fundamental mission is to support the Navy's ability to conduct uninterrupted training and testing, which preserves core Navy readiness capabilities. LMR is an applied research program that funds Navy-driven research needs to support at-sea compliance and permitting. For more information, contact the LMR program manager at exwc_lmr_program@us.navy.mil or visit exwc.navfac.navy.mil/lmr.