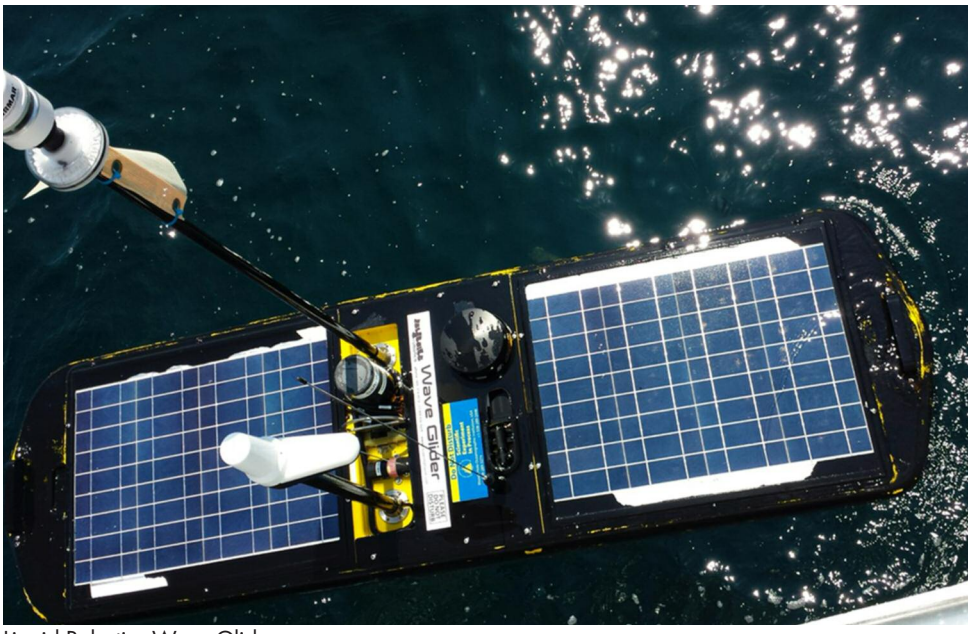
LIVING MARINE RESOURCES PARTNERSHIP PROJECT

Autonomous Real-Time Passive Acoustic Monitoring of Baleen Whales for Mitigating Interactions with Naval Activities

THE NEED

The Navy regularly conducts studies of marine mammal distribution and occurrence in association with training exercises to better monitor potential interactions between marine mammals and naval activities. Methods used for these studies include visual surveys and acoustic monitoring via passive acoustic recorders; however, these methods have significant drawbacks. Visual surveys from ships and airplanes are expensive, and they cannot be conducted during nighttime or periods of high winds, rough seas, or poor visibility. Although passive acoustic recorders have large detection ranges and can be used to persistently detect vocalizing marine mammals regardless of weather conditions, recordings can be accessed only after recovery of the recording instrument. In addition, acoustic analysis by a trained person is time consuming and expensive.



Liquid Robotics Wave Glider.

THE SOLUTION

A cooperative effort of the LMR program and the Environmental Security Technology Certification Program (ESTCP) is applying recent advances in low-power digital signal processors, detection algorithms, and satellite communications that have made near real-time (within hours of sound detection) audio processing, sound detection, classification, and reporting from autonomous platforms feasible. This project will demonstrate a passive acoustic detection and classification hardware/software system that is capable of detecting the calls of four species of endangered baleen whales—fin (*Balaenoptera physalus*), humpback (*Megaptera novaeangliae*), sei (*Balaenoptera borealis*), and right (*Eubalaena glacialis*)—from three different autonomous platforms (Slocum gliders, Wave Gliders, moored buoys). In particular, the project seeks to: (1) demonstrate year-round, large-scale near real-time acoustic surveillance from these autonomous platforms; (2) validate near real-time acoustic detections using audio recorded in situ and airplane-, ship-, and land-based visual observations; and (3) develop best practices for integrating near real-time acoustic detections from autonomous platforms into persistent visual monitoring programs such as the current National Oceanic and Atmospheric Administration (NOAA) and Navy marine mammal aerial survey programs off the U.S. east coast.

METHODOLOGY

The enabling technology for this project is the digital acoustic monitoring (DMON) instrument/low-frequency detection and classification system (LFDCS), a combined hardware (DMON) and software (LFDCS) system capable of detecting and reporting a wide variety of low-frequency vocalizations in near real time. Developed at Woods Hole Oceanographic Institution (WHOI), the DMON collects, conditions, processes, and records audio from up to three attached hydrophones. Because it is programmable, applications can be developed to detect, classify, and report sounds from the collected audio in near real time. The LFDCS is software that detects and describes sounds using pitch tracking, and it classifies those sounds using quadratic discriminant function analysis. The DMON/LFDCS is capable of reporting detection information on a wide variety of calls produced by several species from both mobile and stationary autonomous platforms.

The DMON/LFDCS is deployed on three autonomous platforms—a Slocum glider, a Liquid Robotics Inc. Wave Glider, and a moored buoy. Data are reported via Irridum satellite in real-time and recorded in archival form on the DMON. Real-time data are posted to dcs.whoi.edu and analyzed by researchers at WHOI and NOAA's Northeast Fisheries Science Center. Researchers use visual observations from ship, air, and land-based surveys to ground truth a subset of detections.

SCHEDULE

The objective of the project is to demonstrate the ability of autonomous platforms to perform near-real time detection and classification of baleen whale vocalizations over a variety of spatial and temporal scales. Deployments occur year-round (buoy and Wave Glider) and over six weeks in the spring (Slocum glider). Visual observations are conducted from aerial, land- and ship-based platforms to ground-truth the detections reported by the DMON/LFDCS and to work out best practices for integrating near real-time acoustic detections into ongoing visual surveys. The data collection effort will be complete after three field seasons and analysis will be conducted in the following year.

NAVY BENEFITS

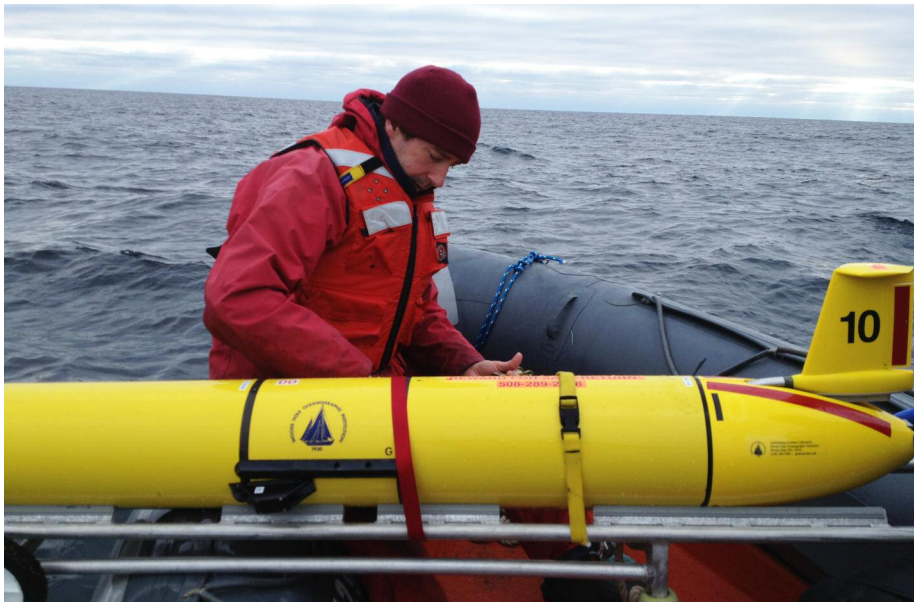
This project will provide flexible tools for reducing analytical effort over the long term and improving the efficiency of existing monitoring technologies (e.g., visual surveys). It is expected that the Navy will be able to significantly enhance its monitoring efforts using near real-time detection information to identify

Fin whale (*Balaenoptera physalus*).

areas of persistent marine mammal occurrence and to direct airplane- or ship-based surveys to regions that require additional visual surveillance.

TRANSITION

The ultimate goal of this project is to transition the technology into use by the U.S. Navy Marine Species Monitoring Program. In order to do so, the technology will be tested on Navy assets and collaborations will be arranged with other Navy offices to ensure access to hardware and personnel with the proper training. Naval Facilities Engineering Command (NAVFAC) biologists are trained on data analysis and hardware programming. During the spring 2016 deployment, an additional demonstration project will include the integration of the DMON/LFDCS with a Navy-owned Slocum glider. NAVFAC biologists will perform data analysis during this deployment. A technology transition plan will be prepared and funding options explored during the last year of the project.



Preparing to deploy a Slocum glider.

ABOUT THE PRINCIPAL INVESTIGATORS

Cara Hotchkin is a bioacoustician with the Naval Facilities Engineering Command, Atlantic, in Norfolk, VA. She specializes in the vocal behavior of animals and effects of noise on marine mammals. Dr. Hotchkin holds a Ph.D. in Ecology from the Pennsylvania State University.

Mark Baumgartner is an Associate Scientist with tenure at Woods Hole Oceanographic Institution, where he has worked for more than 15 years. He uses new technology, novel approaches, and multi-disciplinary collaborations to study aspects of both whale and zooplankton ecology. Dr. Baumgartner's Ph.D. in Biological Oceanography is from Oregon State University.

Sofie Van Parijs applies her expertise in marine bioacoustics to questions on behavioral ecology, distribution, abundance, long term monitoring, mitigation and effects of ocean noise on marine mammals. She currently is the program leader for the passive acoustic research group at NOAA's Northeast Fisheries Science Center, Protected Species Branch. Dr. Van Parijs has a Ph.D. in Zoology from Aberdeen University, UK and has worked from the Arctic to the tropics.

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.