LIVING MARINE RESOURCES PROJECT 44

Demonstration and Validation of Passive Acoustic Density Estimation for Right Whales

NEED

Marine mammal density estimates are a critical input for the Navy's acoustic effects modelling. While traditional ship and aerial visual survey estimates of marine mammal density are standard methodologies for obtaining density estimates, they are very expensive to conduct, are limited in their spatial and temporal coverage and are not effective at documenting cryptic species (species that are difficult to see). The use of fixed-PAM for density estimation has the potential to increase the amount of density data in all US-waters and Navy ranges that can be used in the Navy's acoustic effects modeling. The Navy is interested in demonstrating and validating fixed–PAM based density estimation methods using vessel or shore–based visual surveys on species that have a high confidence level in being sighted.

Southern right whales.
Israel Maciel, Instituto Australis, permit SISBIO 60324-2

SOLUTION

This project will couple shore-based observations with a continuous acoustic recording array to obtain acoustic cues (i.e., vocalizations) for density estimation in a Brazilian population of southern right whales (*Eubalaena australis*). This population offers a useful study opportunity because the population travels close to shore in areas with elevated hillsides suitable for concurrent fixed passive acoustic monitoring and visual observation of individuals. Previous studies with southern right whales from multiple habitats have demonstrated that the acoustic repertoires of all right whale species are similar, with the same call types described for each species. The southern right whale can thus serve as a proxy for the highly endangered North Atlantic right whale (*Eubalaena glacialis*).

The visually-verified acoustic data set will be used to assess and validate a range of PAM density estimation methods for right whales. This approach could also improve the understanding of the sensitivity to variation in biological (age, sex, behavior), environmental (time of day, weather) and anthropogenic (ship noise) parameters.

METHODOLOGY

The team will collect visual survey data concurrently with acoustic recordings of vocally active right whales using a time-synchronized fixed PAM-array. Results will be used to validate range-specific detection probability, false positive rates and cue (or call) rates for estimating acoustic density.

Visual data will be recorded from a land-based survey platform using a theodolite and a visual observation team. Whale presence can reliably be detected out to 8-kilometers (km), but the survey will be focused within a 3 km radius area from the survey platform. The visual observation team will detect, localize and track all right whale groups within that observation area.

Acoustic data will be collected using six underwater sound recorder units (Soundtrap 300 STD) arrayed over the 3km radius observation area. Three additional units will be added to the north, south and east of the visual observation area to determine if sounds come from outside or inside the visual detection area. For example, whales calling offshore will be detected first on the offshore unit, before detection on any of the recordings within the central array.

Additional field efforts to obtain estimates of cue rates to apply to the PAM density estimation approach will include acoustic animal-borne tag (Dtag3) attachments on suitable weather days and focal follows and acoustic tracking of whales within the acoustic array. Density estimation will focus on two cue types (all calls and contact calls).

The effective detection area estimates will be explored through three approaches:

1. **Spatial Capture Recapture (SCR)**
   This will be the primary approach for estimating the effective detection area. It relies on detecting at least some calls on multiple underwater sound recorders.
2. **Extended SCR**
   In addition to hydrophone location, additional information such as received level and time of arrival will be used to make more accurate inferences.
3. **Acoustic model-based assessment of effective detection area (EDA)**
   This will be based on published values for right whale call source levels and acoustic propagation modeling. The EDA estimates will be validated using visually-tracked animals.

Cliff-top observation.
Renata Sousa-Lima, Instituto Australis

Finally, the visually-obtained density of right whales in the bay will be compared to the output of PAM density estimates to validate the approaches applied for estimation of right whale density using passive acoustic methods.

SCHEDULE

Field efforts will be conducted in 2020 and 2021. Acoustic density estimations will begin in late 2020 as field data are available and continue into 2022. Visual and acoustic density estimates will be compared and analyzed in 2022. Research results will be provided in final reports and manuscript submissions.

NAVY BENEFITS

This study will provide a passive acoustic monitoring survey designed for acoustic density estimation of a right whale species with concurrent visual and acoustic localization of right whales. The results of this validation work will allow scientists to better assess the application of different PAM density estimation approaches for right whales. These data will inform density estimation approaches for other right whale species, including the endangered North Atlantic right whale, by providing a better understanding of the variability in cue rates.

TRANSITION

The project will provide the raw acoustic and visual data, analyses of these datasets, peer-reviewed scientific publications and oral presentations at scientific meetings. At the completion of this study, visual survey data collected under the project will be contributed to the OBIS-SEAMAP online database and tag data to the Movebank data repository.

ABOUT THE PRINCIPAL INVESTIGATORS

Susan Parks is an associate professor in the Department of Biology at Syracuse University in Syracuse, NY. She specializes in bioacoustics, focusing on the use of sound for communication and the impacts of noise on development, behavior, sound production and reception. Dr. Parks holds a Ph.D. in Biological Oceanography from the Massachusetts Institute of Technology & Woods Hole Oceanographic Institution.

Len Thomas is Professor of Statistics at the University of St Andrews and specializes in developing statistical methods to apply to ecological problems. Prof. Thomas has a Ph.D. in Forestry from the University of British Columbia.

Key contributor: Julia Dombroski is pursuing her Ph.D. in the Department of Biology at Syracuse University. She will lead the field operations.

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.navfac.navy.mil/lmr.