LIVING MARINE RESOURCES PROJECT 63

Cetacean Caller-ID [CETACID]: Validating Approaches for Identifying Focal Communication Signals Using Acoustic Recording Tags

NEED

The Office of Naval Research (ONR) Marine Mammals and Biology program has previously developed marine mammal tag technology to collect marine mammal movement, diving and acoustic data. Acoustic data from these tags have been useful for detecting sounds received, as well as the sounds produced, by the tagged animal or surrounding animals of conspecifics (i.e., same species). Data specifically from the tagged animals are useful for evaluating baseline behaviors, response and calling or cue rates that may be used in other applications such as estimating detectability or passive acoustic based density estimation methods. Previous approaches have demonstrated the ability of using other sensors on the tags, such as the accelerometer, to link recorded calls to the tagged individual. However, there has not been focused effort on further developing approaches to associate detected calls to the tagged individual. The Navy needs demonstrated approaches and tools for using existing tag sensors to identify which calls detected are associated with the tagged individual.

A humpback whale fitted with a DTAG3 sound and movement recording tag.
Dr. Susan E. Parks (Syracuse University), NOAA permit 18059 held by David Wiley in collaboration with NOAA Stellwagen Bank National Marine Sanctuary

SOLUTION

This project will test a suite of methods to identify focal signals of both baleen and toothed whales in tag data. Unique datasets in which entire groups of animals have been instrumented with acoustic tags that use relatively high accelerometer sample rates (e.g., DTAG3, DTAG4 and newer Acousonde tags) will be used to validate methods. This will provide ground truth data where calls from tagged animals are recorded on both the source animal tag and simultaneously with tags on other nearby conspecifics.

METHODOLOGY

The project team will begin by investigating and refining approaches for call identification in low frequency baleen whale species and mid-frequency toothed whales. Using results from that effort, the team will demonstrate and validate call identification techniques.

Analytical methods for baleen whale call identification to be investigated will include:

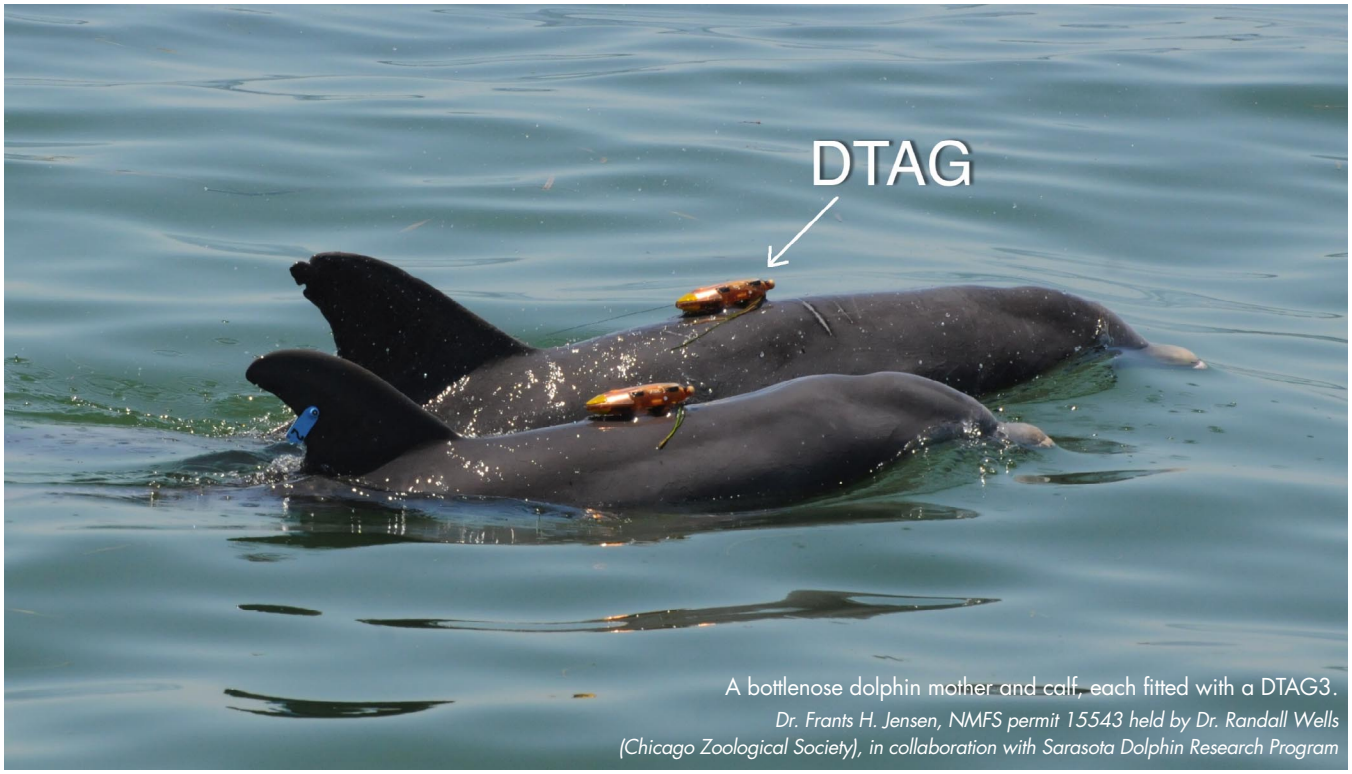
NAVFAC Naval Facilities Engineering Systems Command
EXWC Engineering & Expeditionary Warfare Center

- **Accelerometer vibration intensity**
  Implement existing methods using an accelerometer signal and evaluate multiple approaches to define decision criteria for differentiating focal signals.
- **Sound-to-vibration energy ratio**
  Multiple conditions can affect call detection from accelerometer data, either inflating call rates or missing detections. The team will use this energy ratio to analyze data.
- **Vector sensor localization**
  The team will adapt well-established vector sensor processing techniques, such as those used to localize sounds in DIFAR sonobuoys, to estimate sound direction and identify focal sounds with a consistent direction-of-arrival.

Methods for the mid-frequency species will include:

- **Received level and angle-of-arrival information**
  Researchers will incorporate improved Time Difference of Arrival (TDOA) algorithms into analysis tools for digital acoustic recording tags (DTAG) and use simulations and empirical data to assess how call frequency and bandwidth affect angle-of-arrival estimation.
- **Spectral distortion**
  The team will measure the ratio of fundamental to harmonic energy within calls from prior analyses of dolphin whistles for focal identification.
- **Low-frequency vibrations associated with sound production**
  This will use high sample-rate accelerometers to try to pick up low-frequency vibrations associated with sound production, similar to the accelerometer vibration work for baleen whales.

To validate techniques for caller identification the team will use datasets in which all animals within a social group are simultaneously tagged with acoustic recording tags. For baleen whales, they will collect data on humpback whales in Stellwagen Bank National Marine Sanctuary and will leverage the dataset from LMR Project 44 (Demonstration and



A bottlenose dolphin mother and calf, each fitted with a DTAG3.
Dr. Frants H. Jensen, NMFS permit 15543 held by Dr. Randall Wells (Chicago Zoological Society), in collaboration with Sarasota Dolphin Research Program

Validation of Passive Acoustic Density Estimation for Right Whales) that is focused on Southern right whales in Brazil.

For toothed whales the team will collect data on bottlenose dolphins in Sarasota Bay, Florida, and leverage datasets from an ONR project on small groups of pilot whales in the Strait of Gibraltar (Spain).

An additional effort to integrate tag data and methods into PAMGuard will be considered depending on the results of the previous effort.

SCHEDULE

The primary tasks of methods investigation and demonstration and validation will be completed within the first three years of the project, with an estimated completion in 2026. The project might continue an additional year if PAMGuard integration is determined to be appropriate.

NAVY BENEFITS

This project will help to fill gaps in the ability to quantify individual and group-level cue rates, understand how cue rates depend on behavioral context and how vocal rates change as a function of disturbance. This information will help the Navy's monitoring program with density estimates and understanding more on behavioral responses.

TRANSITION

Project results will be shared through research papers, publications, analytical and data visualization methods for the DTAG toolbox and training materials to support broader use of validated methods.

ABOUT THE PRINCIPAL INVESTIGATOR

Frants H. Jensen, a Senior Researcher at Aarhus University in Denmark, has more than 18 years of experience applying sound and movement recording tags to investigate acoustic ecology of marine mammals and analyzing results using an array of software tools. His work has included developing new MATLAB® tools for analyzing multiple simultaneously deployed acoustic tags to identify focal vocalizations using cross-tag comparisons, and he has used DTAG4 accelerometers to detect throat vibrations associated with sound production in spotted hyenas. Dr. Jensen earned his Ph.D. in biology from Aarhus University.

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 exwc.navfac.navy.mil/lmr.