Healthy Ecosystems Grants 2 Final Report

Project Title: Integrating Visual and Acoustic Data on Cetacean Abundance and Habitat in Gulf of Mexico Deepwater
Award Amount: $450,857
Awardee: Scripps Institution of Oceanography, University of California San Diego
Award Start Date: 12/01/15
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Project Director: John Hildebrand
Affiliation: Scripps Institution of Oceanography, University of California San Diego

Project Key Personnel:

- Kait Frasier, Scripps Institution of Oceanography

I. PROJECT SUMMARY (from proposal)

The deep water Gulf of Mexico provides habitat for a diverse array of cetaceans such as sperm whales, beaked whales and a variety of delphinids. Many of these animals forage deep in the water column and are difficult to study owing to their presence primarily in pelagic waters. Shipboard and aerial line-transect surveys are the standard method for estimating abundance of deep-water cetacean populations, providing a large spatial scale picture at a snapshot in time. The time interval between surveys can be up to several years due to the expense of these platforms, which limits the ability to estimate population trends. Additionally, deep diving species are difficult to sample as they spend limited time at the sea surface. In response to the need for improved monitoring, passive acoustic methods are being developed that use sound produced by the animals to detect their presence. Passive acoustic monitoring provides a complimentary modality for cetacean monitoring; this approach employs acoustic sensors at fixed sites but provides a nearly continuous record of animal presence. The objective of this proposal is to integrate existing spatially rich visual survey data and temporally rich acoustic survey data for deep-water cetaceans to provide improved spatial and temporal understanding of their presence in the Gulf of Mexico.

Beginning in the summer of 2010, an array of six acoustic recorders were deployed in the northern and eastern Gulf of Mexico, within and surrounding the area of the Deepwater Horizon oil spill. These acoustic recorders have produced a nearly continuous record of cetacean presence, at six specific locations. These data are complimentary to line transect visual surveys conducted by the Southeast Fisheries Science Center (NOAA SEFSC) beginning in the 1990's. Visual survey data cover the entire U. S. Gulf of Mexico but at differing time intervals since 1990.

Habitat modeling is a tool for predicting cetacean distributions based on presence data, and associated ecological information. Since marine ecosystems vary both spatially and temporally, many cetacean

species respond to (seasonal and interannual) ecosystem variability by changing their distribution patterns. We propose to integrate data on cetacean presence from passive acoustic monitoring, which has excellent temporal coverage but poor spatial coverage, with sighting data, which has excellent spatial coverage but poor temporal coverage, into cetacean habitat models using environmental data from the Gulf of Mexico. The resulting models are needed to incorporate understanding of cetacean variability into management, including improvement of abundance estimates and better understanding of the potential impact of the Deepwater Horizon oil spill on cetacean populations.

II. PROJECT SUMMARY (from final report)

[PENDING]

III. PROJECT RESULTS

Accomplishments

The goal of this project is to build integrated habitat models for Gulf of Mexico marine mammals using visual survey data, and passive acoustic monitoring data. Primary marine mammal population assessment methods include visual surveys which provide good spatial coverage, but limited temporal resolution, and passive acoustic monitoring, which produces good temporal resolution with limited spatial coverage. We explore methods for using both datasets in tandem to train and test habitat models capable of robust spatial and temporal predictive power. Neural networks are proposed as a promising strategy for this type of combined learning problem, and results are presented for seven marine mammal groups including sperm whales, beaked whales and delphinids.

Implications

Effective marine mammal population management requires the ability to predict species distributions in space and time. The results of this work have advanced the state of the art for marine mammal habitat modeling, and these methods will be used for future understanding of the Gulf of Mexico. The final models and associated information are made available in a publically accessible online format, for use in management and decision making applications.

Unexpected Outcomes

The effectiveness of machine learning techniques for integrating these dataset was an unexpected, but pleasant outcome.

Project Relevance

The following audiences would be most interested in the results of this project:

- Researchers
- Educators
- Community Leaders
- Local Government Officials
- State Government Officials
- Federal Government Officials
- Non-Profit Private Sector
- For-Profit Private Sector

These are the best available data on the spatial distribution and density for deepwater cetaceans in the Gulf of Mexico. They will help guide future environmental assessments of the potential impact of oil and gas and other activities which might impact cetacean populations.

Education and Training

Number of students, postdoctoral scholars, or educational components involved in the project:

- Undergraduate students: 1
- Graduate students: 1
- Postdoctoral scholars: 1
- Other educational components: 1

Models are posted on public www site for use by general public as well as marine mammal science community.

IV. DATA AND INFORMATION PRODUCTS

This project produced data and information products of the following types:

- Scholarly publications, reports or monographs, workshop summaries or conference proceedings
- Websites or data portals
- Models or simulations

INFORMATION PRODUCTS

Information Product Inventory: [PENDING]

Citations for Project Publications, Reports and Monographs, and Workshop and Conference Proceedings:

J. Hildebrand, Passive Acoustic Monitoring in the Gulf of Mexico, GoMMAPS Meeting sponsored by BOEM, February 1, 2016, Tampa Florida.

J.A. Hildebrand. Passive Acoustic Monitoring in the Gulf of Mexico. Gulf of Mexico Oil Spill and Ecosystem Conference 2016.

K.E. Frasier. Gulf of Mexico Pelagic Dolphin Density Trends from Passive Acoustics. Gulf of Mexico Oil Spill and Ecosystem Conference 2016.

J.A. Hildebrand, K. E. Frasier, and S. M. Wiggins. Trends in Deep-Diving Whale Populations in the Gulf of Mexico: 2010 to 2015. Gulf of Mexico Oil Spill and Ecosystem Conference 2017.

K.E. Frasier, R. E. Cohen, V. I. Hernandez, S. M. Wiggins, J. A. Hildebrand. Declining Pelagic Dolphin Detection Rates in the Gulf of Mexico: 2010 to 2015. Gulf of Mexico Oil Spill and Ecosystem Conference 2017.

K.E. Frasier, R. Cohen, J.S. Trickey, S.M.Wiggins, A.S. Berga, M. Soldevilla, L. Garrison, S. Baumann-Pickering, and J. Hildebrand, (2017). Echolocation for restoration: Odontocete monitoring in the Gulf of Mexico. The Journal of the Acoustical Society of America 142, 2533-2533.

Websites and Data Portals:

- Project models are found at: https://goo.gl/MY65na
- Their hosting at OBIS-SEAMAP is underway: http://seamap.env.duke.edu/
- Acoustic data: https://data.gulfresearchinitiative.org/data/R1.x135.120:0019

Models on OBIS-SEAMAP and data on GulfResearchInitiative should be maintained indefinitely.

Other Activities to Ensure Access to Information Products:
OBIS-SEAMAP is the primary www site used by regulatory agencies and the public to discover what is known about marine mammal populations. By putting our models on this site they will be readily available for future use.

V. PUBLIC INTEREST AND COMMUNICATIONS

Most Unique or Innovative Aspect of the Project
[PENDING]

Most Exciting or Surprising Thing Learned During the Project
[PENDING]

Most Important Outcome or Benefit of Project
[PENDING]

Communications, Outreach, and Dissemination Activities of Project
[PENDING]