

## **Environmental Studies Program: Ongoing Study**

**Study Area(s):** National

**Administered By:** Headquarters

**Title:** Developing the Next Generation of Animal Telemetry: A Partnership To Develop Cost Effective, Open-Source, Marine Megafaunal Tracking (NSL #NT-17-x20)

**BOEM Information Need(s) to be Addressed:** This study implements BOEM's Outer Continental Shelf Lands Act mandate to monitor the marine environment adjacent to U.S. Outer Continental Shelf (OCS) operations. Understanding animal movement in the OCS is required for nearly everything under BOEM's purview. Telemetry is an important tool to support animal movement and behavior studies to supplement survey effort. Additionally, animal telemetry can be used to infer movements related to activities in the OCS, such as geophysical surveys, platform construction and demolition. Animal telemetry can provide relevant information for NEPA, MMPA, ESA consultations across program areas such as wind and hydrokinetic placement locations, oil/gas leasing, and even can be used in monitoring impacts of climate change. Internal reports, such as BOEM's Effects of Offshore Energy Sound Producing Activities on Fish and Invertebrates as well as public comments on a variety of EIS, from the Arctic to Atlantic, call for a need for improved data on animal movement, behavioral, and foraging ecology.

**Total BOEM Cost:** \$380,000

**Period of Performance:** FY 2017–2019

**Conducting Organization(s):** NASA

**Principal Investigator(s):** Jacob Levenson ([Jacob.Levenson@boem.gov](mailto:Jacob.Levenson@boem.gov)) and Jennifer Bosyk ([jennifer.bosyk@boem.gov](mailto:jennifer.bosyk@boem.gov))

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### **Description:**

**Background:** Tracking of highly mobile marine megafauna is typically accomplished by Argos or Iridium/Inmarsat satellite. This study proposes development of an alternative method of OCS marine animal tracking by leveraging NASA's CubeSat partnerships with STEM universities and the Automatic Packet Reporting System (APRS). APRS is an amateur radio-based system for real time digital communications with transceivers located on land and low-earth orbit using NASA's CubeSat program.

Animal movement studies face several technological factors due to proprietary technology, limited radio transmission range, overhead satellite time limitations and most importantly, cost. Cumulatively, these factors limit opportunity to gather information on animal movements throughout the U.S. Exclusive Economic Zone. Producing an open-source transmitting tag which does not depend on the ARGOS satellite system significantly lowers costs by enabling use of a constellation of low cost,

open source data relay CubeSats.

The CubeSat pico-satellites community can be leveraged to invest in a CubeSat alternative to the current ARGOS system. CubeSats are a class of small research-class spacecraft. NASA's CubeSat Launch Initiative (CSLI) provides opportunities for small satellite payloads to hitch-hike on rockets planned for upcoming launches. This program engages engineering schools across the United States to develop low-cost micro satellite experiments and has been developing and launching these CubeSats at a rate as high as 100 per year. Some CubeSats have adopted the APRS system for tracking position and relaying data of other transmitters. This is the same system that NASA maintains aboard the International Space Station for outreach to students and amateur experimenters around the world. Additional APRS transreceivers can be placed easily on the future CubeSats, as well as AUVs, ocean going vessels, and existing buoys to create a truly wired ocean.

Marine Mammals, fishes and invertebrates of particular interest for impact analysis include those species that are commercially or recreationally important, are threatened or endangered, or are keystone (for example, important prey) species. Data collected by these tags can be relayed in real-time (or delayed mode) via satellite. Due to limited bandwidth in these transmissions not all of the data can be relayed. This results in a need for some data-processing on the tag and only a subset or summary of the data being recovered. However, as the instrument does not have to physically be recovered these tags can be deployed on animals not suitable for archival tags alone.

The planet is changing quickly, through this study BOEM can be a catalyst for a truly wired ocean. Though the implementation of this project, BOEM achieves improved tools for OCS monitoring, STEM partners are engaged in an innovative program, together leading to a tech savvy workforce while filling in gaps in OCS data cost effectively.

#### Objectives:

- Develop and demonstrate an OCS tracking/monitoring network for geographically and taxonomically diverse marine megafauna leveraging APRS/CubeSat open source tracking
- Demonstrate ability to track and transmit archival tag data using the CubeSat network
- Formalize the transition from the short term experimental licensing of these missions to a permanent UHF allocation for this open source project.
- Describe pelagic megafaunal movements outside the range of existing surveys

Methods: Using NASA's CubeSat launch initiative network we will utilize space-based transceivers aboard CubeSats and the International Space Station as well as ocean and terrestrial based transceivers to demonstrate the feasibility of tracking various marine megafauna. Accomplishing this will be done through the following.

- Develop and launch CubeSats for data link characterization

- Convene a workshop of the CubeSat community as well as ocean telemetry engineering experts to establish a standardized communication platform for low orbital pico-satellites
- Promote and encourage the CubeSat community to utilize APRS digipeater as a part of their communication system. This will drastically increase the number of space assets and coverage
- Convene a public competition to create a coding algorithm for managing big data associated with visualizing movements accurately
- Quantify data collection capability between Argos and CubeSat networks by characterizing the initial proof-of-concept CubeSat missions
- Ground-truth CubeSat animal tags in diverse scenarios

**Current Status:** Interagency agreement currently in review by BOEM procurement department

**Final Report Due:** September 2019

**Publications Completed:**

**Affiliated WWW Sites:**

**Revised Date:** June 19, 2017