Environmental Studies Program: Studies Development Plan | FY 2023–2024

Title	Next Generation of Animal Telemetry: Year II (NT-23-04)
Administered by	Office of Environmental Programs
BOEM Contact(s)	Jacob Levenson (jacob.levenson@boem.gov)
Procurement Type(s)	Inter-agency Agreement/Contract
Conducting Organization(s)	TBD
Total BOEM Cost	TBD
Performance Period	FY 2023–2024
Final Report Due	TBD
Date Revised	January 11, 2022
PICOC Summary	
Problem	Spatial and temporal coverage limitation of telemetry receiving stations lead to data loss and cost ineffectiveness for animal movement studies upon which BOEM and other agencies depend heavily for understanding impacts of activities as well as distribution changes resulting from a changing climate.
Intervention	Leverage growing small-satellite industry, anticipated to be as many as 18,000 orbiting by 2028, to augment current limitations.
Comparison	Change is measured by increased location accuracy and bandwidth available to telemetry needs for an open-source tracking receiver (software-defined radio or global positioning system) that can be included on future small satellites, such as those from academia, government, and industry (Planet, Starlink, etc.).
Outcome	Improved data quality with reduced costs for animal telemetry needs
Context	Global

BOEM Information Need(s): This study implements BOEM's Outer Continental Shelf (OCS) Lands Act mandate to monitor the marine environment adjacent to U.S. OCS operations as well as support for understanding species distributions of commercial value and changes occurring as a result of climate change. 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 efforts. 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 environmental analysis and consultations across program areas such as wind and hydrokinetic placement locations, oil/gas leasing, and even be used in monitoring impacts of climate change. A need for improved data on animal movement, behavioral, and foraging ecologies have routinely been identified in public comments related to energy development and marine mineral extraction.

Background: This study proposes the development of a supplemental/alternative method of OCS marine animal tracking by leveraging NASA's expertise with small satellites and space technologies and using NASA's CubeSat Launch Initiative (CSLI) network and Flight Opportunities 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 the opportunity to gather information on animal movements throughout the U.S. Exclusive Economic Zone. Tracking of highly mobile marine megafauna is typically accomplished by the ARGOS satellite. An open-source receiving network, which does not depend on the ARGOS satellite system significantly lowers costs by enabling the use of a constellation of low-cost, open-source data relay small satellites.

The small-satellite community can be leveraged to invest in a CubeSat alternative to the current ARGOS system. CubeSats are a class of small research-class spacecraft built on an open standard and measuring 10-cm square. 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 microsatellite experiments that have been developing and launching CubeSats from around the world annually. Additional tracking sensors can be placed easily on the future CubeSats, as well as autonomous underwater vehicles, ocean-going vessels, aircraft, and existing buoys to create a truly wireless 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.

This is a continuation of an FY17 study to determine the feasibility of leveraging small satellites for animal telemetry. During that study, a global crowdsourcing ideation challenge took place, as well as tests of commercial off-the-shelf tracking equipment on high-altitude balloons. Workshops were also conducted with the SmallSat and biologging communities. In 2021, we started year 1 of the project. The focus of year 1 was developing the payload sensor package and further iterating to mature the design through testing.

The next step in the project is to continue iterating on the design to complete payload integration. This will be accomplished through prototype testing using high-altitude balloons to characterize functionality and performance. This will support the design of the sensor that will be tested onboard the International Space Station (ISS) and eventually, a constellation of small satellites. The planned activities will also include conducting workshops with the SmallSat and biologging communities.

Through the implementation of this project, BOEM achieves improved tools for OCS monitoring; engaging scientific, engineering, and technology partners in an innovative program; and developing a tech-savvy workforce while filling in information gaps in OCS data cost-effectively.

Objectives:

- Leverage SmallSats and open-source tracking technology to develop and demonstrate an OCS tracking/monitoring network suitable for geographically and taxonomically diverse marine megafauna.
- Demonstrate ability to track and transmit tag data using the SmallSat network.

- Describe feasibility of tracking pelagic megafaunal movements outside the range of existing surveys.

Methods: Leveraging NASA's expertise with small satellites and space technologies for required tracking instruments and using NASA's CSLI network and Flight Opportunities Program, we will utilize space-based transceivers aboard CubeSats and the ISS as well as ocean and terrestrial-based transceivers to demonstrate the feasibility of tracking various marine megafauna.

The aforementioned will support the overall goals of the project:

1. Conduct technology demonstrations as "proof of concept" exercises using commercial hardware on a high-altitude balloon, on the external rack of the ISS, and a small constellation of small satellites.
2. Conduct open-source hardware, software, telemetry, data management systems architecture, and communication protocol workshops with the community of experts as well as ocean telemetry engineering experts to establish a standardized communication platform for low orbital small-satellites.
3. Convene a workshop of the CubeSat community as well as ocean telemetry engineering experts to establish a standardized communication platform for low orbital pico-satellite.
4. Convene a public competition to create a coding algorithm for managing big data associated with visualizing movements accurately.

Specific Research Question(s): Can SmallSats be used as a cost-effective supplement improving improve ocean megafauna monitoring?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

Levenson JJ, Martinez A, Uribe E, Ben-Maor S, Cortez J, Contreras J, Thaler A, Bosyk J. 2021. Developing the next generation of animal telemetry. Sterling (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management. 113 p. Report No.: OCS Study BOEM 2021-060.