Environmental Studies Program: Ongoing Study

Title	Sea Turtle Avoidance Technology Solutions (STATS) (MM-21-02)
Administered by	Marine Minerals Program
BOEM Contact(s)	Jacob Levenson (Jacob.levenson@boem.gov), Doug Piatkowski (douglas.piatkowski@boem.gov)
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Conducting Organization(s)	NASA Center of Excellence for Collaborative Innovation
Total BOEM Cost	$800,000
Performance Period	FY 2021–2023
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PICOC Summary	
Problem	Federally protected sea turtle species may be at risk of entrainment and mortality when Trailing Suction Hopper Dredges (TSHD) are used to excavate sediment from the Outer Continental Shelf (OCS). Mitigation strategies to capture and relocate sea turtles (i.e., relocation trawling) from the project area to minimize dredge entrainment risk have been in place for decades. After over 20 years of implementation, no studies have been done to test the efficacy of relocation trawling in mitigating sea turtle entrainment risk or to assess the risk of incidental impacts to sea turtle behavior and physiology post release as well as impacts to bycatch. Emerging and innovative technological solutions and methods(e.g., sonar and advanced imaging and detection technologies, unmanned aerial vehicles (UAV)/aerial drones, sea turtle telemetry, and movement ecology/occupancy modeling, etc.) for real-time in-situ turtle detection and tracking have not been fully explored to study the efficacy of and make improvements to this practice.
Intervention	This study proposes to implement a suite of existing and new technological solutions and methods for analysis which, combined with BOEM's existing ASTER decision support tool investment (Ramirez et. al., 2017), may result in more informed and targeted use of relocation trawling activities. The efficacy and potential impacts of sea turtle relocation trawling practices will be tested to support future risk based tradeoff evaluations on when, where, and how to best implement this mitigation strategy
Comparison	Detection, localization, and behavior of sea turtles in the project area will be evaluated using innovative technologies relative to catch per unit effort of the relocation trawler and the rate of lethal entrainment by the TSHD.
Outcome	The results of this study will fill long standing data gaps on sea turtle relocation trawling efficacy and will inform future BOEM, NMFS, and USACE tradeoff decisions regarding the incidental risks associated with implementing the mitigation tool relative to the risk of lethal entrainment via a TSHD.
Context	U.S. Atlantic and Gulf of Mexico OCS

BOEM Information Need(s) to be Addressed: After over 20 years of implementing relocation trawling as a mitigation practice for sea turtles, no studies have been done to test its efficacy in mitigating impacts relative to the potential incidental risk to sea turtles and other bycatch. This study proposes to advance emerging technology solutions (e.g., sonar, UAV/aerial drone, telemetry, and automated target identification using machine learning) for real time in-situ sea turtle detection and investigate the efficacy and potential implications of current sea turtle relocation trawling mitigation practices associated with hopper dredging. Results from this effort will directly fill critical sea turtle distribution and abundance data gaps relative to project specific relocation trawling and TSHD operations and inform future tradeoff decisions at BOEM (Marine Minerals Program (MMP)), NMFS, and USACE. Sea turtle behavior and physiology information collected during this study will complement ongoing BOEM funded sea turtle telemetry studies in the Atlantic and Gulf of Mexico ((Hart et. al., (ongoing study; NSL #MM-19-03)). These results will also inform protected species effects analyses associated with National Environmental Policy Act (NEPA) documents and Endangered Species Act (ESA) consultations. This study will strive to adhere to Executive Order 13840, Ocean Policy to Advance the Economic, Security, and Environmental Interests of the United States, by bringing together partners across the disciplines of machine learning, artificial intelligence and integration with autonomous systems.

Background: Federally protected sea turtle species are at risk of entrainment and mortality when TSHD are used to excavate sediment from the OCS. A suite of measures to mitigate entrainment risk including TSHD equipment and operational modifications, protected species observers, and relocation trawling were developed over 30 years ago and continue to be implemented today with limited consideration of recent technological advancements and opportunity for improvements. When sea turtles may be present in the project area and at risk of dredging entrainment, NMFS may require sea turtle relocation trawling operations (i.e., modified shrimp trawler) for two primary mitigative purposes: (1) to assess pre-dredging species abundance and distribution and (2) to physically capture and relocate from the immediate vicinity of dredging operations. However, though relocation trawling operations are intended to mitigate dredging entrainment risk, they may also expose sea turtles to other incidental risks and result in the capture of unintended species, known as bycatch. Concerns have recently been raised by NMFS, USACE, and BOEM regarding the incidental risk of this mitigation practice to sea turtles and other protected species. Specifically, it is unclear (1) how sea turtles redistribute after relocation, (2) what percentage of turtles at risk of TSHD entrainment are removed by relocation trawling and c) how are the behavior and physiological responses to stress evident across sea turtle species and age classes. Absent these data, BOEM, NMFS, and USACE lack the ability to make informed tradeoff decisions on whether relocation trawling serves as an appropriate project specific mitigation tool. Significant BOEM investments have already been made in the Atlantic and Gulf of Mexico at active and proposed OCS borrow areas to understand protected sea turtle species behavior and distribution which will be leveraged for the purpose of this study (Hart et. al., (ongoing study; NSL #MM-19-03)).

In addition to the risk of injury and mortality of protected species and other bycatch, relocation trawling may only provide a brief glimpse in time/space of sea turtle presence and abundance at a given site. However, in situ monitoring coupled with the trawling data may afford a more comprehensive spatial and temporal view of animals present and their behavior. Implementing existing and new technological solutions for in-situ monitoring can dramatically improve both the effectiveness and timeliness of animals observed while significantly reducing costs and risks associated with relocation trawling.

Objectives: The objectives of this study will be to: a) develop a comprehensive assessment of sea turtle abundance within an area to be trawled; b) gather information on sea turtle movement during and after relocation trawling to identify the extent site fidelity/residency factors into relocation effectiveness; c) determine the effectiveness of alternative detection methods; d) test the efficacy of current relocation trawling methods in reducing TSHD entrainment risk; and e) develop/build upon open source computer vision for detecting sea turtles and other species of interest to decrease analysis time as a benefit to MMP operations nationally (Dickerson et.al., 2018).

Methods: This study will rely on integrating a tiered system of advanced technological solutions, which will address the objectives identified above. These methods include the use of unmanned vehicles for assessing sea turtle abundance (Goebel et al. 2015, Kiszka et al. 2016, and Fuentes et al. 2015). Understanding abundance at the surface will also be combined with testing the use of an acoustic imaging camera for presence/absence of sea turtles in the immediate vicinity of trawling activities based on prior studies done by USACE (Dickerson et al., 2018). Acoustic approaches have long been used for remote species identification, however, range of effectiveness varies. Various telemetry techniques, both acoustic telemetry and Fastloc® GPS telemetry will be used to understand the site fidelity of a relocated sea turtle (Witt et al. 2010). Fastloc® gps will afford an understanding of how likely the turtle is to reappear in a previously trawled area.

Computer vision, leveraging OpenCV and ground-truthed against visual observations for accuracy, will be used to expedite data analysis. Once in-water and/or aerial images are captured, they can be processed using a convolutional neural network. Neural networks are a means of implementing machine learning where the computer learns to perform tasks through the analysis of training examples. Neural nets have demonstrated reliability in the automation of object detection in imagery and can be applied to visual and acoustic target imaging analysis used in this study (Gray et. al., 2018; Carter et. al., 2014). These data will be further utilized in relevant ongoing BOEM studies that would incorporate the data into ecosystem modeling.

The proposed study sites include active or proposed OCS borrow areas and control sites. These sites are in areas where existing data on sea turtle abundance can be used to compare to autonomous vehicle and forward-looking sonar or high-resolution videography (provided water clarity). Observations will be analyzed via employing existing statistical procedures along with more complex statistical analyses and comparisons of spatial and temporal patterns of detection.

Specific Research Question(s):

1. What is the effectiveness of relocation trawling at reducing risk of sea turtle entrainment?
2. What is the impact of site fidelity on relocation trawling effectiveness?
3. How can alternative and emerging technologies be leveraged to detect abundance and distribution of sea turtles within a borrow area and in the path of active extraction?
4. Can alternative technologies mitigate for sea turtle entrainment and reduce impacts to associated species?

Current Status: STATS is being completed in two parts: 1) a public data science challenge to look for new methods to predict the effectiveness of preventative trawling for sea turtles; and 2) follow-on fieldwork informed by step 1. Step 1 is currently underway through NASA’s Center of Excellence for Collaborative Innovation.

Publications Completed: None

Affiliated WWW Sites: None

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