Environmental Studies Program: Ongoing Study

Title	Behavioral Effects of Sound Sources from Offshore Renewable Energy Construction on the Black Sea Bass (*Centropristis striata*) and Longfin Inshore Squid (*Doryteuthis pealeii*): A Field Study (AT-20-01)
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Brian Hooker (brian.hooker@boem.gov)
Procurement Type(s)	Cooperative Agreement
Conducting Organization(s)	Woods Hole Oceanographic Institution (WHOI)
Total BOEM Cost	$763,550
Performance Period	FY 2020–2023
Final Report Due	September, 2023
Date Revised	March 21, 2022
PICOC Summary	
Problem	This study is principally addressing fisheries resource impacts from offshore wind energy development and thus not only addresses impacts to the fishery resource itself, but on the U.S. private and public sectors that rely on the resource for commercial and recreational use, respectively.
Intervention	This study would evaluate the physical and physiological impact to fish and/or molluscs during construction of an offshore wind energy facility.
Comparison	This second phase project will compare field measurements to lab-based results.
Outcome	The outcome will be a better understanding of the physical, physiological, and behavioral impacts to fish associated with offshore wind construction activity.
Context	The principal target for the investigation is commercially important fish in the North and Mid-Atlantic Planning Areas, principally black sea bass and longfin squid. The percussive action of pile-driving offshore wind foundations has the potential to induce physical or behavior impact to fish. This study will evaluate that potential in a field setting.

BOEM Information Need(s): The information from this study will help in BOEM's noise impact assessments to commercial fish species under the National Environmental Policy Act and the Essential Fish Habitat provisions of the Magnuson-Stevens Fishery Conservation and Management Act.

Background: Auditory thresholds for some commercial fish species have been established while for some species such as black sea bass data are lacking. Black sea bass in particular support valuable commercial fisheries in the North, Mid, and South Atlantic Planning Areas. Black sea bass show affinity for certain habitats within the wind energy lease areas and are thus not a temporary resident of these lease areas (Guida et al 2017). Commercial and recreational fishermen have expressed concern that noise produced during sub-bottom surveys, pile-driving, and operation of renewable energy facilities may have a negative effect on the behavior of black sea bass ranging from catchability to long-term reproductive success. This species is known to detect mid-frequency acoustics (80–1000 Hz) which may be used as environmental indicators but their sensitivities to anthropogenic sounds such as pile driving

noise, and their behavioral responses to them, is not understood (Stanley et al., 2020). Sounds that could lead to acute or chronic sub-lethal effects may be generated as a result of offshore wind development. Black sea bass could be vulnerable because they are known to use acoustic cues to communicate and because their habitats overlap within renewable energy lease areas. If feasible, other priority species, such as squid, identified in the Normandeau 2012 study (BOEM Contract # M11PC00031) may be evaluated. This study is divided into two parts. Part one is a laboratory study awarded as an interagency agreement with the National Oceanic & Atmospheric Administration's (NOAA's) Northeast Fisheries Science Center in 2017 and this profile describes part two, which is the companion field study.

Objectives: The objectives are to examine the effects of offshore windfarm construction noise on two key commercially and ecological important taxa, squid and black sea bass, using field-based controlled exposures to actual *in situ* pile driving and associated vessel noise.

1. Characterize the relevant acoustic pile driving signals in pressure and particle motion (in the water column and on the benthos) at varying distances during offshore construction. Carry-out field-based controlled exposures.
2. Quantify the movement, energetic patterns and potential displacement of free-swimming squid and BSB using high-resolution, movement and behavior tags and moored echosounders. The goal is to evaluate potential changes in swimming energetics, swimming patterns and overall displacement from an area.
3. In caged and location-controlled animals examine distance and sound-level dependent impacts to:
    a. Representative, sexually mature reproductive adults schooling and shoaling of squid and BSB, including impacts to communication, group cohesion/predator avoidance, mating behaviors and breeding. The goal is to evaluate critical behavioral impacts to schools and small populations of animals, impacts would influence future populations through disturbance to breeding, intraspecific mating communication, and susceptibility to predators. Multiple spatial scales (distances) and sound levels will be addressed.
    b. Potential hearing loss for in situ exposed animals. The goal is to determine if there are physiological, auditory impacts due to acoustic pressure or particle motion; impacts which could influence sensory systems and balance.
    c. Development and potential premature hatch of immobile squid embryos and egg mops. Initially, in the first year of the study, controlled environment pilot studies will be carried out to better understand the temporal and spatial scope needed to transfer the methods to the field. The goal here is to measure whether pile driving, and construction noise exposure will induce premature hatching and late-stage developing embryos, thus a potential impact on future cohorts.
4. Address the overall influence on the biological community around squid and BSB and their habitats, using moored echosounders. The goal is to evaluate whether potential predator or prey availability are also influenced by pile driving. Such data are key, particularly for squids, given their important role a central trophic link in marine food webs.

Methods: The study will occur by conducting experiments and observations of longfin squid, black sea bass and the surrounding ecosystem at set distances before, during and after pile driving events (or control, no-sound days). The project will follow a before-during-and-after gradient (BAG) design, where

potential significant changes from baseline in the variables of interest are assessed using statistical methods that allow for the exploration of changes in spatial relationships over time.

Specific Research Question(s): Does sound generated during offshore wind construction affect important fish species like black sea bass and squid? At what amplitude do pile-driving or other project sounds induce a behavioral response? At what amplitude do these sounds lead to physiological damage to the auditory system?

Current Status: The project was awarded in September 2020. Field work is underway.

Publications Completed: None

Affiliated WWW Sites: https://www2.whoi.edu/site/amooney/

References:

Normandeau Associates, Inc. 2012. Effects of Noise on Fish, Fisheries, and Invertebrates in the U.S. Atlantic and Arctic from Energy Industry Sound-Generating Activities. A Workshop Report for the U.S. Dept. of the Interior, Bureau of Ocean Energy Management. Contract # M11PC00031. 72 p. plus Appendices.

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Hawkins AD, Popper AN. A sound approach to assessing the impact of Underwater noise on marine fishes and invertebrates. ICES Journal of Marine Science. doi:10.1093/icesjms/fsw205.

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