

STATEMENT OF WORK

Feel the Vibrations: Behavioral Response by Fishes and Invertebrates to Particle Motion and Substrate Vibration from Offshore Renewable Energy Development (NT-23-10a)

PURPOSE

There are only a handful studies that have examined impacts of water-borne particle motion on fishes and aquatic invertebrates. This study will build on BOEM's previous investment to broaden our knowledge on the magnitude and scope of the potential behavioral effects of particle motion and substrate-borne vibration on susceptible species by examining 1) multiple fish and invertebrate species, 2) a suite of behavioral responses—acute, chronic, and/or biologically meaningful, and 3) behavioral responses in a realistic pile-driving scenario.

BACKGROUND

Offshore construction activities, particularly impact pile-driving, produce significant energy that is transmitted into the water column and through the substrate. Substantial progress has been made in understanding the extent and magnitude of the effect that acoustic pressure waves in the water column have on marine life, especially on marine mammals. Acoustic energy is also coupled into the seafloor as substrate vibration that is well-described by directional particle motion (Hawkins et al. 2021). The scientific community has become increasingly aware that most fish and invertebrates sense sound through particle motion (Hawkins et al. 2021). Several studies, including ongoing BOEM-funded studies (AT-20-01/M20AC10009), have begun to explore study designs for assessing behavioral response in free-swimming fish (Spiga et al. 2017) and squid (Jones et al. 2020a, 2020b; Cone et al. 2022), and bivalves (Roberts et al. 2015; Jézéquel et al. 2022) to acoustic exposure that include measurements of particle motion. But there are many species of fish and invertebrates that live at or within the substrate. Very little research has focused on behavioral responses of these species to the vibroacoustic disturbances in the substrate. Therefore, there is an explicit need for a study of demersal fish and invertebrate species to particle motion and substrate-borne vibration to fill this knowledge gap. In fact, at the 2020 workshop on the state of the science related to wildlife and offshore wind energy development, the expert working group identified behavioral response studies of priority taxa to particle motion and substrate vibration as a key research priority for the next five years (Popper et al. 2022). The fishing community has also raised concerns on this topic.

The proposed study builds on recent BOEM investments, like Real-Time Opportunity for Development of Environmental Observations (RODEO), which included physical measurements of particle motion during construction of the Block Island Wind Farm (Amaral et al. 2018, OCS Study BOEM 2018-029) but did not address its potential behavioral effects on marine organisms. It also builds on an ongoing BOEM study (AT-20-01) of behavioral effects of offshore construction sound on freely swimming black sea bass and squid to include additional species fishes and/or aquatic invertebrates. The added outcome gained through this study will broaden BOEM's understanding of anthropogenic particle motion on fishes and aquatic invertebrates.

REFERENCES

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AWARD INFORMATION

Total project allocation for FY23 is \$450,000. No study proposal may have a budget exceeding \$450,000 in funds requested from BOEM. Matching contributions from the applicant are strongly recommended. BOEM anticipates that there would be a single award as part of this project. Eligible applicants are included in C1 of the funding opportunity announcement.

OBJECTIVES

The goal of this study is to provide insight about the potential effects of particle motion and substrate-borne vibration from pile-driving activity on demersal fish and invertebrates through a dedicated empirical behavioral response study. The results will provide sufficient empirical evidence—by considering a range of behaviors that are acute, chronic, and/or biologically significant. Insight will also be gained on the relationship between changes in the vibroacoustic field and behavioral responses.

DESCRIPTION OF WORK

Methods: The proposed study is for a behavioral assessment of fishes and/or aquatic invertebrates during actual pile-driving (preferred) or simulated pile-driving activity (acceptable) and will include a control to assess baseline behavior without pile-driving activity. Measurements will be made of the vibroacoustic field (must include particle motion and substrate vibration), using appropriate tools for each type of vibroacoustic wave. The study output will provide appropriate context for assessing the cause of any observed changes in behavior by including measurements and/or documentation of other relevant disturbances and environmental factors. The objectives will be achieved through one or more field studies, with the intention of examining a vibroacoustic field that is representative of offshore construction pile-driving.

Potential field methods to observe animals near pile-driving may include, but are not limited to the following:

- Animal-mounted sensors (e.g., accelerometers) to measure fine-scale movements (e.g., startle responses, lateral movements, feeding behaviors).
- An acoustic telemetry array to monitor larger-scale movements (e.g., habitat-displacement).
- *In situ* cages equipped with video cameras and/or tagged animals.
- Simulated pile-driving or playback experiments¹ in a small bay or saltwater pond where animals can easily be observed and/or recaptured if tagged.

Potential species may include (listed by approximate priority, preference to include multiple species):

- Flatfish (e.g., common sole, winter flounder)
- Bivalves (e.g., scallop, clam, mussels)
- Crustaceans (e.g., American lobster, crabs)
- If multiple species are examined, species should represent a range of life history strategies, mobility, and hearing abilities, and preference to species with commercial/conservation importance (Popper *et al.* 2022).

¹ Approach will need to ensure the simulated vibroacoustic field has similar characteristics to actual pile-driving.

TASKS

Generally, the project applicants will describe the tasks necessary to accomplish the listed objectives and within the general methodology described above over the expected 36-month period of performance. Prescribed tasks include:

Task 1: Conduct a post award project kick-off meeting.

- a. Schedule a post award online project kick-off meeting that includes the Contracting Officer (CO), Project Officer (PO) or Contracting Officer's Representative (COR), BOEM Environmental Studies Program Representative (ESP Rep), principal investigator, and other key personnel involved in the study.
- b. Discuss with BOEM experts on the scope and timeline of the project.

Task 2: Develop study plans on experimental design and data analyses so the desired products listed in Deliverable 1 can be accurately obtained.

Task 3: Quarterly reports that summarize progresses of this study and percent completed for each task.

Task 4: Work with BOEM experts on the draft report, technical summary, and final report that details all the tasks and results listed above.

ESPIS Data Deliverables Requirements

- Final Report and Technical Summary: The copies of the narratives of study results in both the MS Word and Adobe Acrobat (PDF/A) formats, without any password protections, following the ESP Report Specifications.
- Study Footprint: The geographic information that enables the referencing of the study using a GIS, following the study footprint specifications.
- Study Footprint Metadata: The scientific attribution information required to enhance discoverability of the study in the ESPIS system and third-party sites (such as data.gov), following the study footprint metadata specifications.
- Study Map: The study area map embedded in the Final Report and Technical Summary that depicts the study footprint and that is cited in the study footprint metadata.
- Federal Geographic Data Committee (FGDC) compliant metadata for each scientific dataset: The scientific, technical, and administrative information for each coherent unit of scientific data, including the physical medium, file information, volume, and access URL, when applicable.
- Include boilerplate language in every ESP contract/agreement.
 - Copy of related publications: "The manuscripts of scholarly publications and conference presentations for research funded by this [contract/ agreement] for free and unlimited use by BOEM staff, which may take the form of a full-text, final, pre-

- publication copy of the related publication in cases that the publisher enforces pay for access or copyright restrictions.”
- Bibliographic information for related publications: “The information on each related publication needed for formatting CSE [Council of Science Editors] bibliographies using the name-date system

Data Management Plan

- All data (including raw acoustic datasets and associated metadata) from this study will be delivered to BOEM and shared at a specific public repository (e.g., National Center for Environmental Information).
- All acoustic modeling codes developed specifically for this study will be shared with BOEM and made open-source.
- Existing modeling software used in this study but are not developed specifically for this study may be proprietary, however, BOEM will prioritize the use of open-source software and modeling tools when considering award.

Scientific Integrity

Scientific integrity is vital to Department of the Interior (DOI) activities under which scientific research, data, summaries, syntheses, interpretations, presentations, and/or publications are developed and used. Failure to uphold the highest degree of scientific integrity will result not only in potentially flawed scientific results, interpretations, and applications but will damage DOI’s reputation and ability to uphold the public’s trust. All work performed must comply with the DOI Scientific Integrity Policy posted to <http://www.doi.gov>, or its equivalent as provided by their organization or State law.

DELIVERABLES

(1.) Post-award Teleconference: Under the moderation of the BOEM project officer (PO) and the BSEE contract officer for this cooperative agreement (CO), a post-award teleconference will be conducted. The participants will be the PO, CO, BOEM ESP Rep, and the principal investigator who performs the study. The teleconference will be conducted as soon after the BOEM funding award as is practical under the scheduling constraints of the participants.

A synopsis of the kick-off meeting will be drafted by the PO and distributed to the Chief of the Environmental Sciences Division and to all the participants of the teleconference.

(2.) Study Plan(s): The principal investigator shall produce study plan(s) detailing: Experimental design, data collection, and data analysis and dissemination.

(3.) Quarterly Progress Reports: The principal investigator shall produce quarterly reports briefly stating: progress made in the past quarter; any particular problems needing BOEM intervention to resolve; and anticipated progress to made in the next quarter.

(4.) Draft Final Report and Technical Summary: The principal investigator shall complete and submit a draft final report and draft technical summary to BOEM for scientific peer and

editorial review. The report and technical summary shall be in the format specified at <http://www.boem.gov/Environmental-Studies-Program-Report-Specifications/>. The report shall contain the following language concerning its availability in ESPIS:

“To download a PDF file of this Environmental Studies Program report, go to the U.S. Department of the Interior, Bureau of Ocean Energy Management, Environmental Studies Program Information System website and search on OCS Study BOEM xxxx-xxx.”, where xxxx-xxx will be replaced with the assigned BOEM study number.

In addition, in the Acknowledgement of Sponsorship Section, the report shall contain the following disclaimer and acknowledgement language:

“Disclaimer: This report has been technically reviewed by BOEM, and it has been approved for publication. The views and conclusions contained in this document are those of the authors and should not be interpreted as representing the opinions or policies of the U.S. Government, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.”;

and

“Acknowledgement: Study collaboration and funding were provided by the U.S. Department of the Interior, Bureau of Ocean Energy Management, Environmental Studies Program, Washington, DC under Agreement Number _____.”.

(5.) Final Report and Final Technical Summary: The principal investigator shall revise the draft final report and draft technical summary according to feedback given by BOEM reviewers and the PO. She shall provide three high-quality, bound paper copies of the revised final report suitable for reproduction and five (5) CD-ROMs or DVDs each containing searchable text in the pdf format of the final report with book marks and a pdf copy of the final technical summary.

Deliverables, Due Dates, and Distribution

Deliverable	Distribution	Due Date
A. Post Award Teleconference and Summary Notes	Chief, DES—One (1) electronic copy ESP Rep—One (1) electronic copy CO—One (1) electronic copy All other participants in the teleconference—One (1) electronic copy	As soon as practical after BOEM funding award Summary Notes due approximately one (1) week after teleconference

Deliverable	Distribution	Due Date
B. Study Plan(s)	Chief, DES—One (1) electronic copy ESP Rep—One (1) electronic copy PO—One (1) electronic copy CO—One (1) electronic copy	Within two weeks after the Principal Investigator and BOEM reaches agreement on study design and data collection, analysis, and dissemination processes.
C. Quarterly Reports	Chief, DES—One (1) electronic copy ESP Rep—One (1) electronic copy PO—One (1) electronic copy CO—One (1) electronic copy	Within four (4) months from award and Quarterly afterward.
D. Draft Report and Technical Summary	Chief, DES—One (1) electronic copy (in MS Word format) ESP Rep—One (1) electronic copy (in MS Word format) PO—One (1) electronic copy (MS Word) for report CO—One (1) electronic copy of transmittal letter only	Draft due two (2) months prior to the end of the period of performance
E. Final Report and Technical Summary	Chief, DES—One electronic copy (in pdf format) ESP Rep—One (1) electronic copy (in pdf format) PO—One (1) electronic copy (in pdf format), three (3) bound paper copies and five (5) CD-ROM copies, containing both the technical report and the technical summary in	Before the end of the period of performance

Deliverable	Distribution	Due Date
	Adobe Acrobat (.pdf) format and labeled with the study title, BOEM report number, BOEM contract number, contractor name and date CO—One (1) copy transmittal letter only	