Environmental Studies Program: Ongoing Study

Field	Study Information
Title	Understanding Biological Connectivity Among Offshore Structures and Natural Reefs (PC-19-04)
Administered by	Pacific OCS Regional Office
BOEM Contact(s)	Susan Zaleski (susan.zaleski@boem.gov), Mark Mueller (mark.mueller@boem.gov)
Procurement Type(s)	Cooperative Agreement
Conducting Organization(s)	University of California, Santa Barbara
Total BOEM Cost	$945,000 (includes Environmental Studies Program and Pacific Region funds)
Performance Period	FY 2019–2025
Final Report Due	April 19, 2025
Date Revised	November 1, 2023
Problem	How biologically connected are platforms to each other as well as mainland and Island Natural reefs. How does this connectivity influence non-indigenous species (NIS)? Would reefed platforms enhance the presence of NIS on natural reefs?
Intervention	Utilize genetic analyses to test connectivity hypotheses.
Comparison	Compare genetic results to oceanographic modeling to confirm/refute hypotheses of connectivity and ecological value for invertebrate communities.
Outcome	Utilize study results to inform National Environmental Policy Act (NEPA) reviews for decommissioning and siting of renewable energy facilities.
Context	All Pacific outer continental shelf (OCS) planning areas (U.S. West Coast and Hawaii)

BOEM Information Need(s): BOEM needs to confirm/refute these hypotheses to have a definitive answer when conducting environmental reviews for decommissioning alternatives and potential marine renewable energy installations. This will also enable BOEM to comply with the duties of Federal agencies that are outlined in Section 2 of Executive Order 13112 (Invasive Species).

Background: Oceanographic modeling suggests various degrees of potential connectivity among Pacific OCS platforms, harbors, and natural habitat for invertebrate taxa with a representative range of planktonic larval durations (PLD) that provides a basis for hypothesis testing using genetic analyses (Simons et al. 2016). Particular taxa of interest include the NIS *Watersipora subtorquata*, with a very short PLD of 24 hours, and two native bivalves, a scallop and a mussel, both with PLDs of days to weeks. Dispersal of these invertebrate species to new sites occurs during the planktonic larval stage when they can be transported from a parent population to other artificial and natural habitats by ocean currents. The degree of exchange of these propagules between source and destination sites is a measure of habitat connectivity. Anthropogenic structures, such as offshore oil platforms and shipwrecks, provide novel attachment substrate for encrusting invertebrates, and it has been proposed that these structures

increase habitat connectivity by serving as "stepping stones" that may increase the potential success of dispersal (Sheehy and Vik 2010; Adams et al. 2014). As such, artificial substrate may facilitate the establishment and spread of NIS and other species by providing novel habitats where none existed previously, and may provide a source of larvae of native species such as the rock scallop and sea mussel to populations in natural habitats (Mineur et al. 2012).

Objective(s): The overall objective of this study is to test hypotheses on biological connectivity among artificial and natural habitats using genetic markers.

Methods: To meet the overall study objectives, three tasks will be performed.

1. Use molecular markers to test the prediction that populations of species with short PLDs will be more similar genetically in habitats in close proximity than those farther apart, whereas, the genetic structure of native species will be more homogenous across sites.
    a. Scuba divers will sample NIS and native species on (a) oil and gas platforms, (b) harbors, (c) shipwrecks, and (d) nearby natural reefs in sufficient detail for the genetic analysis. Next-generation sequencing (NGS) technology will be used to profile genetic variation of the target species and genotypes will be determined by counting multi-sample alleles.
2. Estimate biological connectivity among anthropogenic structures and natural reefs using the data from task 1 and standard genetic connectivity estimates, and use these results to identify possible sources of larvae to platforms and natural reefs.
    a. These results will build on previous studies' predictions of potential connectivity developed from oceanographic and larval tracking modeling. This task will model larval dispersal pathways to and from oil and gas platforms, harbors, shipwrecks, and reefs and identify vulnerable steps in the life history of NIS that can be used to manage future colonization risk (see task 3). In addition, it will assess the role that platforms may have as a source of scallop and mussel larvae to natural habitats.
3. Develop an early detection and rapid-response monitoring plan.
    a. Once the biological data have been collected and synthesized with other available information, the study will assess the effects of location and spacing of artificial structures on natural biological communities that will inform biological effects from spacing of potential renewable energy installations and develop an early detection and rapid-response plan. This plan may include managing point sources and vectors, and other potential actions. Finally, the study will examine potential Rigs-to-Reefs proposals and how they may affect the risk of NIS establishment to natural habitats.

Specific Research Question(s):

1. Is invertebrate species dispersal greater in the offshore than in the nearshore environment?
2. Are there distinct genetic structures on groups of offshore platforms, harbors, shipwrecks, and natural reefs for native and non-native species?
3. Is gene flow between populations more restricted for species with spatially limited planktonic dispersal?
4. Do the genetic structures lead to confirming specific pathways for non-native species introductions?

5. What are the effects of location and spacing of artificial structures on natural biological communities?

Current Status: The cooperative agreement with University of California, Santa Barbara was fully executed on September 10, 2019, and was modified in September 2020 to include additional data analysis tasks and funds. SCUBA sampling is underway on platforms, harbors, and natural reefs. Fieldwork and lab analysis were delayed due to COVID-19; however, investigators have accomplished some work with a scaled-back approach. The period of performance was extended to accommodate missed fieldwork and data analysis due to the COVID-19 pandemic. PIs presented their initial results at Aquatic Sciences 2023 and plan to present at Ocean Sciences 2024. They continue to analyze data.

Publications Completed: None

Affiliated WWW Sites: None

References:

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Sheehy DJ, Vik SF. 2010. The role of constructed reefs in non-indigenous species introductions and range expansions. Ecol Eng. 36:1–11.

Simons RD, Page HM, Zaleski S, Miller R, Dugan JE, Schroeder DM, Doheny B. 2016. The effects of anthropogenic structures on habitat connectivity and the potential spread of non-native invertebrate species in the offshore environment. PLOS ONE 11(3):1–16.