Environmental Studies Program: Ongoing Study

Study Area(s): Southern California, Central California, Northern California, Washington-Oregon, Hawaii

Administered By: Pacific OCS Region

Title: Predicting the Consequences of Wave Energy Absorption from Marine Renewable Energy Facilities on Nearshore Ecosystems (NSL #PC-13-05)

BOEM Information Need(s) to be Addressed: The purpose of this study is to develop a statistical model that predicts the potential effects of wave energy absorption from marine renewable energy facilities on nearshore ecosystems. The need for this information is to predict which siting alternatives of proposed wave energy facilities may generate detectable changes in nearshore ecosystems, especially kelp forests. BOEM will use results from this study for impact assessments contained within NEPA documents, and also in essential fish habitat coordination and consultation requirements established by the 1996 reauthorization of the Magnuson-Stevens Fishery Conservation and Management Act.

Total BOEM Cost: $500,000 **Period of Performance:** FY 2014–2018

Conducting Organization(s): U.S. Geological Survey

Principal Investigator(s): Dr. Kevin Lafferty

BOEM Contact(s): Donna Schroeder

Description:

Background: To perform environmental analyses, BOEM requires information about the sensitivity and resilience of biological habitats to disturbance. Because little is known about how activities related to wave energy conversion devices on the outer continental shelf might affect nearshore habitats, numerous scientific reviews rank this information gap as a priority for future research. Some nearshore coastal marine communities are sensitive to wave energy, most notably kelp forests. Kelp forests provide a number of important ecosystem services and have been identified as habitat areas of particular concern (a subset of essential fish habitat) by the Pacific Fisheries Management Council. Thus, it is important to assess how reductions in wave energy might affect these habitats.

Objectives: The objective of this study is to use existing data to build a statistical model that describes how wave energy may structure nearshore communities, and to use this information to predict the ecological consequences of various siting options for proposed marine renewable energy facilities.

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

1. *Determine the distribution of wave period and amplitude across the study region.* Using historical buoy data and oceanographic wave models, data will be generated and developed through use of GIS to show the distribution of nearshore wave energy throughout the study region. The maps will indicate the natural variation in exposure experienced by nearshore communities, helping to put into context potential human alterations to wave dynamics. The maps will also provide inputs needed for building a model of how nearshore communities respond to variation in wave exposure. The Coastal Data Information Program will provide algorithms that compute wave energy as a function of swell direction, amplitude and period for each point along the coastline of the study region. This program has been supported by BOEM and its oceanic swell data come from sensors on Pacific Platform Harvest. By parameterizing the algorithms with historical data from Harvest, monthly plots will be made for maximum, average, and cumulative wave heights for the duration of the available data. This will indicate annual, seasonal and spatial variation in wave exposure in the study region.

2. *Determine how wave model predictions relate to empirical observations along a depth gradient.* Wave models are coarse in their predictions and not fine-tuned to smaller spatial scales where species interact, and they do not indicate wave energy at different depths. The physics of breaking waves leads to attenuation of force and turbulence with depth. To extrapolate wave model predictions to forces acting on specific subtidal sites in marine communities, one must measure wave energy in the field at different depths and compare this to model predictions. Real time wave energy sensors will be deployed in the field to sites with a known variation in wave exposure (e.g., Pt. Conception) to determine the relationship between buoy projections, depth and wave forces that create environmental disturbances such as displacing kelp. The resulting model will expresses wave disturbance as a function of depth and wave period and amplitude.

3. *Determine how marine communities respond to variation in wave exposure.* Kelp forests are sensitive to wave exposure and we presume that they are adapted to average conditions in the region. Wave action could affect various ecological factors, such as recovery rates from disturbance, productivity and biodiversity. Examining the sensitivity of these factors to wave exposure requires a long data set where community time series can be analyzed at several different sites. These long-term data sets exist and are presently being organized and analyzed by the BOEM-funded *DOI Partnership: Distinguishing Between Human and Natural Causes of Changes in Kelp Forests Using Long-term Data from DOI Monitoring Programs.* Wave energy will vary both in time and space, and allow the creation of statistical models that express nearshore communities as a function of wave energy in time and space. In this case, wave energy will be estimated from wave models as in task 1, and adjusted according to site depth as in task 2. With such statistical models, it will be possible to estimate a change in community state that might result from a change in wave energy state. For instance, one could predict changes to the nearshore community that would result if a renewable energy facility reduced the average

amplitude of waves on shore by 10%. Due to non-linearities in the response of communities to waves, these models could predict where renewable energy facilities would lead to significant changes and whether these changes were considered positive or negative in terms of ecosystem services. Generalized linear models will be used to express how wave disturbance, as identified in task 2, affects temporal and spatial variation in the biodiversity, productivity and resilience of nearshore ecosystems using data derived from the *DOI Partnership* study.

Current Status: A website was developed to track deployments. Field data collections are complete. The statistical model developed in this project from deployments predicted wave data as well as or better than the Southern California Regional Swell model. Field data were also calibrated and compared to the Coastal Data Information Program to determine if this model could be used to extrapolate into areas that were not measured by *in situ* measurement. Results were that CDIP generally did well except in extreme events. The next step is to hindcast wave data and compare with long-term kelp forest monitoring data. Two additional papers have been drafted.

Final Report Due: December 2018

Publications Completed:

Lafferty, K. D., F. Henderikx, A. Rassweiler, and L. Washburn. 2016. Using existing monitoring data to understand how wave energy affects nearshore communities. California Ocean Renewable Energy Conference, November 1-2, 2016, University of California, Davis, CA. https://www.boem.gov/CORE-Lafferty/

Affiliated WWW Sites:

https://marinecadastre.gov/espis/#/search/study/26980
https://www.boem.gov/CORE-Lafferty/

Revised Date: July 13, 2018