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Estimating distribution of sedimentary benthic habitats and species on the eastern Pacific shelf and detecting effects of device deployment

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ABSTRACT

The Northwest National Marine Renewable Energy Centre at Oregon State University aims to close key gaps in understanding the technical, ecological, and human dimensions of wave and wind energy development. The Henkel lab investigates benthic conditions and biological communities on the shelf in order to establish an understanding of baseline habitat characteristics, species distributions and abundances against which potential project-induced changes may be assessed. We also aim to develop an understanding of temporal and spatial variability in benthic conditions and species to inform the intensity of sampling needed for future studies. Under baseline conditions, infaunal invertebrates showed little temporal variability but had high spatial heterogeneity related to grain size and depth. Conversely, fish exhibited little spatial variability across the limited depth ranges of the study; however, strong seasonal and interannual trends were detected. Thus, different sampling regimes will be required to adequately assess the range of what is 'normal' for each group before potential impacts can be assessed.

INTRODUCTION

The Northwest National Marine Renewable Energy Center (NNMREC) at Oregon State University is a United States Department of Energy-funded center charged with facilitating the development of marine renewable energy through research, education, and outreach. We aim to serve as a neutral voice of science to inform the public and decision-makers about the potential capabilities and effects of MRE technologies.

The Pacific Marine Energy Centre (PMEC) is the collective name for a suite of test facilities operated by NNMREC. The PMEC North Energy Test Site (NETS) is a non-grid connected, open-ocean test site located ~ 2.5 nautical miles NW of Newport, Oregon, USA. The site is one square nm and ranges 45 – 55 meters deep. The first WEC test took place August to October 2012 with a WET-NZ device and our Ocean Sentinel analysis buoy. In summer 2013 we deployed only the Ocean Sentinel. The PMEC South Energy Test Site (SETS) is a proposed 4 square nm, grid-connected, open-ocean test site ~ 5 nm SW of Newport, ranging 60 – 70 m deep.

For the purposes of planning and siting (including developing appropriate permitting stipulations and measures to mitigate potentially adverse impacts), the distribution of and differences in organisms among sedimentary habitats is needed by regulatory and resource agencies. In order to assess potential project-related changes to species or assemblages, baseline data on temporal and spatial variability in species distributions and abundances is required. Once devices are deployed, we aim to assess potential near field and far field effects on organisms inhabiting sedimentary benthic habitats.

METHODOLOGY

Infaunal Invertebrates

From 2010 through the present (2014) we have surveyed 12 to 16 stations within and surrounding the PMEC-NETS site 3 – 6 times per year to assess local spatial and temporal variability in benthic habitat conditions and infaunal invertebrate species distributions. A total of fourteen box core-sampling trips have been made to the NETS **site.** The aim of this intensive baseline research is to inform the spatial and temporal sampling frequency that may be required to characterize a site and distinguish potential project-related changes from natural variability. We began sampling PMEC-SETS in 2013 to determine if patterns and trends observed at NETS can be applied to the nearby SETS site. In addition to the repeated sampling at NETS and SETS, we conducted similar studies at 8 other sites (a total of 194 additional stations) from northern California to Washington a single time each between 2010 and 2012 to determine how applicable observations from the Newport area may be to the region.

At each station, benthic cores of 0.1 m^2 were collected using a modified Gray-O'Hare box core. Subsamples of sediment from the undisturbed surface layer and from mid-core were collected and used to determine percent silt-clay and median grain size (MGS). The mid-core sample also was used to determine total organic carbon (TOC) and total nitrogen (TN). The remainder of the core was sieved through a 1.0 mm mesh, and retained macrofauna were preserved in 5% formalin. At each station, a CTD cast collected salinity, temperature, and dissolved oxygen (DO) data.

In the laboratory, specimens were sorted into live and dead assemblages; live assemblage specimens

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were then sorted by phylum and identified to the lowest possible taxon, which was usually species.

For grain size analysis, samples were run through a Beckman Coulter LS 13 320 Laser Diffraction Particle Size Analyzer,. A Carlo Erba NA1500 analyzer was used for TOC and TN analysis.

Groundfishes

We also have surveyed the PMEC-NETS area 3 – 6 times per year since 2010 to assess local spatial and temporal variability in groundfish (mostly flatfish) species distributions. A total of eighteen beam trawl-sampling trips have been made to the NETS site from June 2010 to February 2014. We sampled two other sites in Oregon in 2011 to determine how applicable observations from Newport may be to the state.

For fish collection, we used a 2-meter wide by 70-cm high beam trawl with a 3-millimeter (mm) mesh liner. Tows were conducted for 10 min, and a constant speed of ~1.5 knots was attempted. A meter wheel on the trawl provided measures of the distance the trawl was on the bottom. For the trawl surveys, 9 stations were sampled on each visit. Upon bringing the collection on board most fish were sorted into major groups, promptly euthanized and frozen. Elasmobranchs (skates, dogfish, ratfish) were identified, measured, and released. Upon return to the lab, fish were sorted by species and counted.

OBSERVATIONS

Baseline Spatial and Temporal Patterns

Sediment characteristics and infaunal invertebrate species distributions have remained largely stable at NETS over the course of the study; however, species assemblages showed high within-site spatial heterogeneity related to depth. Infaunal distributions and abundances are similar at NETS and SETS; however, these sites were unique from other sampled sites in the region, largely due to unique sediment conditions off Newport. Throughout the entire study region, species assemblages were closely tied to sediment characteristics and depth.

Fish abundances showed stronger seasonal variability, and some inter-annual differences have been detected, but distributions are largely consistent throughout the study site. From a regional perspective, differences in depth within a site were greater than differences between central and southern Oregon.

Project-related Observations

In 2012 and 2013, we were not able to detect any far-field (500+ m) effects from the deployment of one to two small devices on the habitat or benthic species distributions. However, we had some observations of very near-field changes to the seabed. We observed with an ROV in 2012 and collected with the box corer in 2013 substantial accumulation of shell hash around the anchors. As compared with grabs taken from reference stations at the same depth, there was nearly 30 times as much shell hash (as measured by weight per volume of sample) in the grabs taken within 150 m of the anchors. Conversely, there was very little difference in the median grain size of the underlying sediment. However, there was a significant decrease in the number of associated infaunal organisms. Approximately half as many species and less than half the total number of organisms were collected from these high shell hash stations as compared to reference stations.

We did not conduct beam trawl surveys very near the installations. However local fishermen reported some fish attraction around the wave energy buoy but not around the Ocean Sentinel in 2012.

CONCLUSIONS

The results of this study indicate that characterizing infaunal invertebrate distributions and abundances requires fairly detailed knowledge of depth and sediment conditions at a site (potentially requiring site-specific physical surveys with relatively high spatial intensity). However, if those parameters are known, habitat suitability for particular infaunal species or assemblages may be predictable without biological sampling. While spatial sampling may be intense for characterizing infaunal invertebrates, they may be sampled only annually due to lack of observed seasonal variability. We were able to detect changes to infaunal invertebrate abundances very near-field (< 200 m) to a small installation; however, these effects were not detected at reference stations 500+ m away from the installation. Questions remain about the cumulative effects of large numbers of anchors supporting an array of devices and if such near field effects would converge to result in site-wide changes and population-level impacts.

Results of this study indicate that characterizing fish distributions and abundances would require more frequent sampling but potentially less spatial sampling, and baseline data from one site may be an appropriate proxy for sites of grossly similar habitat regionally. While the beam trawl may be effective at characterizing baseline conditions and potentially far field effects at a site, it is not a feasible tool for assessing near field effects (due to the difficulty of trawling among project components) or upper water column effects (such as FAD effects).

The overall aim of environmental assessments is to develop a robust study design capable of detecting environmental changes while keeping costs associated with environmental monitoring appropriately scaled to the cost of a project. We expect that the high intensity sampling conducted by our academic institution to assess the effort required to characterize habitats, species, and detect potential changes will inform the development of appropriately scaled standards for the consenting process.

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