Environmental Studies Program: Ongoing Study

Title	Archaeological and Biological Assessment of Submerged Landforms off the Pacific Coast (PC-14-04)
Administered by	Pacific OCS Region
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Procurement Type(s)	Cooperative Agreement
Conducting Organizations(s)	San Diego State University
Total BOEM Cost	$1,399,414
Performance Period	FY 2015–2021
Final Report Due	February 28, 2021 (report expected April 2022)
Date Revised	March 24, 2022
PICOC Summary	
Problem	Off the Pacific Coast of North America, rising postglacial sea levels have submerged a vast paleolandscape that almost certainly contains inundated terrestrial archaeological resources, many of which are also associated now with important marine biological features.
Intervention	This study will synthesize specific geological and geophysical data from offshore southern California and central Oregon, conduct field investigations, refine local sea-level models, and determine if these features are associated with ecologically sensitive areas.
Comparison	This study will provide important information on better methods for characterizing submerged paleolandforms. Information from similar studies conducted in the Gulf of Mexico and Atlantic regions will be reviewed as well.
Outcome	The project will further improve identification of submerged cultural and natural resources on the continental shelf by evaluating the geophysical survey guidelines for biological, pre-contact archaeological, and paleontological resources.
Context	Fieldwork for this study will occur near the Northern Channel Islands of southern California and central Oregon; however, the study will be applicable for the entire Pacific OCS Region, except Hawaii.

BOEM Information Need(s): BOEM has received applications for both offshore wind and offshore wave projects on the Pacific OCS. To better understand the potential impacts this development can have on submerged cultural landforms, a science-based analysis of these potential resources is necessary. Furthermore, some of these features may also be associated with critical biological habitats. An assessment of submerged landforms on the POCS will assist BOEM, individual States, and Tribal communities in evaluating proposed offshore renewable energy projects, and with developing appropriate information-gathering protocols and survey measures to avoid or mitigate adverse effects to National Register (eligible or listed) Native American archaeological sites during POCS development. BOEM will use this information in NEPA documents, and NHPA, ESA, and EFH consultations, as well as

government-to-government consultations with Native American tribes. Further, this information will inform decisions regarding lease sales, notices to lessees, information to lessees, and will be useful in developing mitigation measures.

Background: Because the spatial jurisdiction of BOEM lies entirely offshore beneath the surface of the water, a fundamental starting point that aids all phases of BOEM decisionmaking on the OCS is to characterize the seafloor. USGS and NOAA have conducted extensive hydrographic surveys along the Pacific Coast. Additionally, a recently completed BOEM study, *Inventory and Analysis of Coastal and Submerged Archaeological Site Occurrence on the Pacific OCS* (POCS Inventory), will provide a digital elevation model of the Pacific OCS paleolandscape and an analysis of where intact paleolandforms might be expected. The next step in the process is to ground-truth some of these target areas. This study will attempt to determine if landforms are being identified correctly from the geophysical data acquired under current guidelines, and if these buried landforms may have the potential to be associated with preserved pre-contact sites.

Objectives: The overall objective of this study is to develop a process that will enhance the ability for BOEM to detect and avoid affecting potential submerged archaeological features and high productivity areas on the Pacific OCS.

Methods: To accomplish the objectives of this study, the follow tasks will be performed:

1. *Evaluate existing remote sensing data and review current theories on sea level rise during the Last Glacial Maximum (LGM) to identify high probability areas for further testing.* Extensive seafloor mapping data collected by BOEM, NOAA, and USGS, historical information on sea level changes, modeling from the POCS Inventory, and anthropological and biological information in the scientific literature will be used to identify submerged relict features that could represent paleolandforms and may function as loci for sensitive ecological resources.
2. *Identify potential submerged landforms and habitats that could indicate high productivity sites on the Pacific OCS*. After synthesizing available information on seafloor character, bathymetry, etc. into a geographic information system that outlines submerged landforms in the area of interest, ecological productivity and subsidy flows will be summarized and overlayed on the spatial information.
3. *Conduct fine-scale survey and ground-truth at least four submerged landform features in each of the targeted areas (offshore southern California and central Oregon).* Various methods will be used to ground-truth identified features, including state-of-the-art remote sensing technology (e.g., bathymetric echo sounders; side-scan and high-resolution [CHIRP] sub-bottom sonar; high penetration sub-bottom sonar; and magnetometers [for targeted application], remotely operated vehicles, and core samples). Cores will be taken from each site and analyzed to identify, date, and characterize potential archaeological sites and to assist in reconstructing the region's paleoenvironment. Biological sampling will identify high productivity habitats.
4. *Analyze new data for possible indicators of pre-contact human activity and* high productivity habitats and their subsequent subsidy flows *associated with submerged landforms.* Analysis for identifying potential submerged cultural landforms will include, at a minimum, remote sensing and coring data collected through this effort, a review of existing theories on sea level rise during the LGM, human migration patterns, and terrestrial analogs, among others. Assessment of biological resources will include a seafloor habitat description according to the Coastal and

Marine Ecological Classification Standard, and an estimate of the species richness and density of important species, including corals and managed fish species.

5. *Evaluate the influence of high-productivity landforms and coastal processes on the structure of coastal food webs*. Once identified, the trophic footprint of productivity "hotspots" across habitats will be evaluated using (1) field surveys to document biodiversity and relative densities of characteristic fauna, and (2) isotopic analyses which will reveal the spatial extent of trophic subsidy due to the unique signature of highly productive areas (e.g., hydrocarbon seeps and macrophyte detritus concentrations) when compared to primary production from phytoplankton.
6. *Develop and refine a model that can be used to interpret remote sensing data and seafloor maps in other areas along the Pacific Coast in order to better identify submerged pre-contact and high productivity sites and classify their associated resources.* Analyses will include recommendations for processing future remote sensing data collected to support BOEM-permitted activities on the Pacific OCS and for appropriate survey parameters to better identify these resources as well as a ranking of coastal habitats and landform features by productivity.

Specific Research Question(s):

1. What are current theories of Late Pleistocene/Early Holocene sea level rise and site formation processes?
2. What is the potential for intact paleolandforms on the Pacific OCS and what is the best methodology to locate these features in order to avoid or minimize impacts from BOEM-permitted activities?

Current Status: The cooperative agreement between BOEM and SDSU was awarded August 18, 2015. All fieldwork and analysis have been completed and the draft final report is under review.

Publications Completed:

Braje TJ, Maloney JM, Gusick AE, Erlandson JM, Nyers A, Davis L, Gill KM, Reeder-Myers L, Ball D. 2019. Working from the Known to the Unknown: Linking the Subaerial Archaeology and the Submerged Landscapes of Santarosae Island, Alta California, USA. In Open Quaternary, 5(1), p. 10. https://www.openquaternary.com/articles/10.5334/oq.66/

Erlandson JM, Braje TJ, Ainis AF, Culleton BJ, Gill K, Hofman CA, Kennett DJ, Reeder-Myers LA, Rick TC. 2020. Maritime Paleoindian Technology, Subsistence, and Ecology at an ~11,700 Year Old Paleocoastal Site on California's Northern Channel Islands, USA. Plos One. https://doi.org/10.1371/journal.pone.0238866.

Erlandson J, Braje T, Ainis A, Culleton B, Gill K, Hofman C, Kennett D, Reeder-Myers L, Rick T. 2021. A Paleocoastal Western Stemmed Tradition Variant from the California Channel Islands. In The Western Stemmed Tradition-Clovis Debate Far West, edited by Katelyn McDonough, Jordan Pratt, and Richard L. Rosencrance. University of Utah Press, Salt Lake City.

Gusick AE, Braje TJ, Erlandson JM, Maloney J, Ball D. 2019. Above and Below the Waves: Advances in the Search for a Late Pleistocene Colonization of California's Islands. In The Archaeology of Island Colonization, edited by Matt Napolitano, Jessica Stone, and Beau Dinapoli. University Press of Florida, Gainesville.

Klotsko S, Skakun M, Maloney J, Gusick A, Davis L, Nyers A, Ball D. 2021. Geologic controls on paleodrainage incision and morphology during sea level lowstands on the Cascadia shelf in Oregon, USA. Marine Geology, 434(3-4):106444. https://www.sciencedirect.com/science/article/abs/pii/S0025322721000268

Laws AW, Maloney JM, Klotsko S, Gusick AE, Braje TJ, Ball D. 2020. Submerged paleoshoreline mapping using high-resolution Chirp sub-bottom data, Northern Channel Islands platform, California, USA. Quaternary Research, 93(1), 1-22.

Marris E. 2015. Fishing for the first Americans. In Nature, International Weekly Journal of Science. 08 September 2015. http://www.nature.com/news/fishing-for-the-first-americans-1.18334

Wade L. 2017. On the Trail of Ancient Mariners. In Science, 357 (6351), 542-545. 11 August 2017. http://www.sciencemag.org/news/2017/08/most-archaeologists-think-first-americans-arrived-boat-now-they-re-beginning-prove-it.

Affiliated WWW Sites:

https://www.boem.gov/PC-14-04-Fact-Sheet/
https://marinecadastre.gov/espis/#/search/study/100088

References: None