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**Biological Studies**

**Ongoing (2014–2022) — Potential Impacts of Submarine Power Cables on Crab Harvest**

This two-part research effort is to learn more about whether the electromagnetic fields (EMF) emitted from subsea power-transmission cables may affect the movement and harvest of commercial crab species. The first part was conducted by the University of California, Santa Barbara, which collected data on red rock crab in the Santa Barbara Channel and Dungeness crab in Puget Sound. The second part is collecting and analyzing additional data.

*Study Profile:* <https://www.boem.gov/pc-19-02/>

**Ongoing (2017-2022) — Seabird and Marine Mammal Surveys Near Potential Renewable Energy Sites Offshore Central and Southern California**

This study by the U.S. Geological Survey will provide up-to-date information on species composition, distribution, abundance, and seasonal variation of seabirds and marine mammals from the Monterey Bay National Marine Sanctuary to the U.S.-Mexico border. Data generated will be used for environmental review of renewable energy projects proposed in this area. Previously collected data will be assessed and analyzed to allow for comparisons with the newly collected data to identify changes in distribution and abundance of seabirds and marine mammals over the last 40 years.

*Study Profile:* <https://www.boem.gov/pc-17-01/>

**Ongoing (2019–2022) — Development of Computer Simulations to Assess Entanglement Risk to Whales and Leatherback Sea Turtles in Offshore Floating Wind Turbine Moorings, Cables, and Associated Derelict Fishing Gear Offshore California**

This study, in partnership with the National Oceanic and Atmospheric Administration's National Centers for Coastal Ocean Science, has developed morphologically and behaviorally accurate 3-D computer models of protected whale species (fin and humpback) and leatherback sea turtles. Two offshore floating wind mooring systems are currently under digital development. The whale and mooring system models will be integrated into simulations to visualize various potential interaction scenarios, including considering associated derelict fishing gear. These simulations will assist BOEM in assessing the risk and potential severity of entanglement, and potentially identify mitigation measures to reduce any risk.

*Study Profile:* <https://www.boem.gov/pr-19-ent-profile/>

*Infographic:* <https://www.boem.gov/PR-19-ENT-Infographic>



### **Ongoing (2019-2023) — California Deepwater Investigations and Groundtruthing (Cal DIG) II**

This study is a partnership between BOEM, National Oceanic and Atmospheric Administration, and U.S. Geological Survey to map geologic features and characterize seafloor habitats offshore California and Oregon. It will enhance understanding about the location and nature of biologically sensitive communities, including in potential lease areas for wind energy development and areas where conventional energy is being developed.

Study Profile: <https://www.boem.gov/pc-19-06-profile/>

### **Ongoing (2020-2024) — Offshore Acoustic Bat Study along the California Coastline**

This study by the the U.S. Geological Survey will expand monitoring of seasonal bat migration activities offshore and along the coast of California, and will produce regional datasets. It will quantify the extent and seasonality of bat activity in the nearshore area of the California coast and increase BOEM’s understanding of the temporal and spatial distribution of bats in the area to evaluate the potential effects of offshore wind energy development on them.

Study Profile: <https://www.boem.gov/PC-19-03-profile>

### **Ongoing (2020–2023) — Over Water Migration Movements of Black Brant**

This study by the U.S. Geological Survey will increase BOEM’s understanding of the temporal and spatial distribution of Black Brant offshore of the Pacific coast to evaluate potential effects of offshore wind energy development on them. BOEM’s objective is to collect data on trans-oceanic and coastal migration routes for Black Brant along the Pacific coast of North America to identify their spatial location, timing, and flight altitudes. The results will help determine if the routes overlap with proposed Call Areas for wind energy development off the Pacific coast.

Study Profile: <https://www.boem.gov/pc-20-01-profile/>

### **Ongoing (2020–2023) — ADRIFT: Spatial and Temporal Distribution of Cetaceans in the California Current Ecosystem Using Drifting Archival Passive Acoustic Monitoring**

This study by the National Oceanic and Atmospheric Administration will collect and analyze passive acoustic data in the California Current Ecosystem to improve understanding of the distribution of protected cetacean (whale, dolphin, and porpoise) species, including in the vicinity of wind energy Call Areas offshore northern and central California. It will employ a novel method of using drifting acoustic recorders, allowing for data to be collected over larger spatial and temporal scales compared to traditional methods. The findings will assist BOEM in assessing potential impacts and overall acoustic contribution of BOEM-regulated activities.

Study Profile: <https://www.boem.gov/PC-20-04>

### **Ongoing (2020–2022) — Assessing and Advancing Individual Matching Accuracy of Photographed Gray Whales Using Artificial Intelligence**

This study by Wild Me is proceeding in two phases. The first phase tested the feasibility of using machine learning algorithms to match lateral ridges of individual gray whales (*Eschrichtius robustus*), and has been completed. The second phase is focusing on increasing the accuracy of these algorithms to match laterally photographed gray whales. Complementing existing efforts funded by NOAA’s National Marine Fisheries Service Southwest Fisheries Science Center, this study aims to use artificial intelligence to better understand the distribution, status, and sensitivities of this species. Products will be incorporated into an open-source distributed database.

Study Profile: <https://www.boem.gov/pr-21-gry>

First Report (BOEM 2021-059): <https://www.boem.gov/BOEM-2021-059>



### **Ongoing (2021–2023) — The Environmental Status of Artificial Structures Offshore California**

This study by the Southern California Marine Institute will use relevant ecological indicators (e.g., biodiversity, biomass, productivity) to improve understanding of how local and/or regional factors influence the variation in environmental status observed in marine infrastructure/facility/obstruction habitats within the Pacific Region, especially offshore California. Study results will assist BOEM in evaluating proposed plans that involve significant amounts of marine infrastructure (which function as de facto artificial reefs) and to gain insight in determining if existing energy infrastructure affects other uses of the outer continental shelf.

Study Profile: <https://www.boem.gov/pc-20-02>

## Ongoing (2021–2023) — A Vulnerability Index to Scale Effects of Offshore Renewable Energy on Marine Mammals and Sea Turtles of the U.S. West Coast (VIMMS)

This study by Southall Environmental Associates (SEA), Inc. will develop a vulnerability index based on the best available data and expert elicitation for marine mammals and sea turtles that occur offshore central and northern California, Oregon, and Washington. This index will assist in scaling the effects and prioritizing which of these species need to be considered in assessments of risk from offshore renewable energy infrastructure. It will develop a visual representation of the levels of concern for relevant species or species groups, which will also inform the selection of renewable energy sites.

Study Profile: <https://www.boem.gov/pc-21-04>

## Ongoing — BOEM-MARine (Multi-Agency Rocky Intertidal Network)

This long-term and continuing study by BOEM and a network of partners provides for the monitoring of rocky intertidal habitats and communities at 32 coastal sites adjacent to existing and potential OCS energy development in California and Oregon. Site-specific data about the diversity and abundance of invertebrates are housed in a publicly available database that can be used to monitor intertidal communities.

Study Profile: <https://www.boem.gov/pc-19-01/>

MARine Website: <http://www.pacificrockyintertidal.org/>

MARine Highlights: [https://epis.boem.gov/final%20reports/BOEM\\_2020-053.pdf](https://epis.boem.gov/final%20reports/BOEM_2020-053.pdf)



## Completed (2010) — Pacific Coast Fisheries GIS Resource Database

This study by the U.S. Geological Survey compiled marine fisheries and coastal spatial data from various wildlife agencies in California, Oregon, and Washington and integrated it into a single, comprehensive GIS-based system. The database includes information about Pacific Coast fish, fisheries, and active fishing, as well as southern California seabirds and marine mammals.

Database: <https://www.usgs.gov/centers/werc/science/pacific-coast-fisheries-gis-resource-database>



## Completed (2011) — Effects of EMF from Undersea Power Cables on Elasmobranchs and Other Marine Species

This study by Normandeau Associates synthesized data and information about subsea power-transmission cables and the sensitivity of marine organisms to electromagnetic fields (EMF) produced by the cables. It produced a database of information about potentially affected species of elasmobranchs (sharks and rays), other fishes, marine mammals, sea turtles, and invertebrates. It also recommended future research priorities and potential mitigation measures.

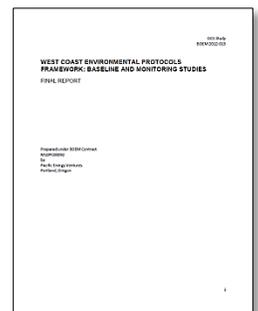
Report (BOEMRE 2011-09): <https://epis.boem.gov/final%20reports/5115.pdf>



## Completed (2012) — West Coast Environmental Protocols Framework: Baseline and Monitoring Studies

This study by Pacific Energy Ventures provides a framework for identifying natural resources and ecological issues to monitor for proposed wave, tidal, and offshore wind projects along the U.S. West Coast.

Report (BOEM 2012-013): <https://epis.boem.gov/final%20reports/5219.pdf>



## Completed (2014) — Survey of Benthic Communities Near Potential Renewable Energy Sites Offshore the Pacific Northwest

This study by Oregon State University provided baseline information about the seafloor environment and the types and distribution of benthic invertebrates in areas of potential renewable energy development on the Washington, Oregon, and northern California OCS. Knowledge of species-habitat relationships will allow for prediction of seafloor communities beyond those sampled in this study.

Report (BOEM 2014-662):

Volume 1: <https://epis.boem.gov/final%20reports/5453.pdf>

Volume 2: <https://epis.boem.gov/final%20reports/5454.pdf>

Webinar: <https://www.boem.gov/Science-Exchange-4/>

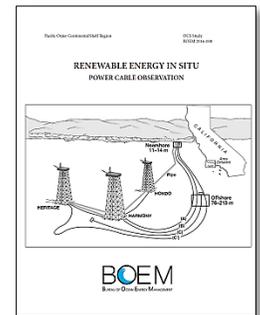


## Completed (2016) — Renewable Energy *in situ* Power Cable Observation

This study by the University of California, Santa Barbara measured the strength and variability of electromagnetic fields (EMF) along subsea power transmission cables in the Santa Barbara Channel, which are similar to cables used for offshore renewable energy inter-device electrical connections. It also compared fish communities in cable versus natural habitats and determined the potential effectiveness of cable burial as a mitigation measure to decrease EMF.

Report (BOEM 2016-008): <https://epis.boem.gov/final%20reports/5520.pdf>

Webinar: <https://www.boem.gov/Science-Exchange-3/>



## Completed (2016) — Using Ongoing Activities as Surrogates to Predict Potential Ecological Impacts from Marine Renewable Energy

BOEM and the U.S. Department of Energy partnered on this study to identify and analyze data from ongoing projects and activities (surrogates) with stressors and receptors similar to those expected from marine renewable energy projects. Two reports examined potential impacts of electromagnetic fields from operating power cables, and one examined mooring configurations of offshore surrogates such as aquaculture facilities and oceanographic buoys as fish attracting devices.

First Report (BOEM 2015-021): <https://www.boem.gov/2015-021/>

Second Report (BOEM 2015-042): <https://www.boem.gov/2015-042/>

Third Report (BOEM 2016-041): <https://www.boem.gov/2016-041/>



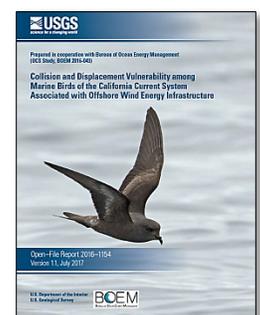
## Completed (2016) — Developing and Applying a Vulnerability Index for Scaling the Possible Adverse Effects of Offshore Renewable Energy Projects on Seabirds on the Pacific OCS

This BOEM-directed study, conducted and primarily funded by the U.S. Geological Survey, developed a comprehensive database to evaluate 81 marine bird species in the California Current System (CCS) in terms of their collision and displacement vulnerability from offshore wind energy infrastructure. It used existing and newly analyzed at-sea behavioral information (e.g., avian habits and activities, flight-height, and flight characteristics) and population metrics to identify species-specific vulnerabilities at the population level. The vulnerability assessment results can now be combined with recent marine bird at-sea distribution and abundance data for the CCS to help address seabird conservation during the siting and operation of offshore wind energy development projects.

Report (USGS OFR 2016-1154, BOEM 2016-043):

<https://pubs.er.usgs.gov/publication/ofr20161154>

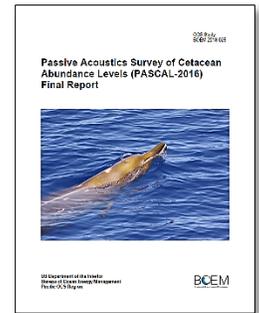
Webinar: <https://www.boem.gov/Science-Exchange-6/>



## **Completed (2018) — California Current Cetacean and Ecosystem Assessment Survey and Use of Data to Produce and Validate Cetacean and Seabird Density Maps**

This study by the National Marine Fisheries Service/Southwest Fisheries Science Center focused on listening for whale species that are difficult to detect during visual surveys because of their deep diving habits and limited surface activity.

Report (BOEM 2018-025): [https://epis.boem.gov/final%20reports/BOEM\\_2018-025.pdf](https://epis.boem.gov/final%20reports/BOEM_2018-025.pdf)

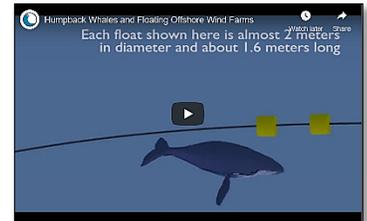
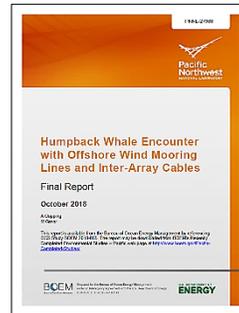


## **Completed (2018) — Humpback Whale Encounter with Offshore Wind Mooring Lines and Inter-Array Cables**

This study by the U.S. Department of Energy/Pacific Northwest National Laboratory compiled information about whale movements (e.g., dive depths and swimming speed) and created a three-dimensional video animation of how whales may move through a hypothetical offshore floating wind farm. This visual simulation will help characterize the risk of whale encounters with mooring lines and electrical cables used in offshore floating wind projects.

Report (BOEM 2018-065): <https://www.boem.gov/BOEM-2018-065/>

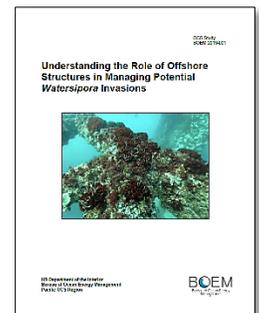
Video Animation: <https://www.boem.gov/Humpback-Whales-Floating-Wind/>



## **Completed (2019) — Understanding the Role of Offshore Structures in Managing Potential Watersipora subtorquata Invasions**

This study by the University of California, Santa Barbara surveyed the distribution and abundance of a non-native bryozoan on 23 platforms and natural reefs in the Southern California Bight, and elucidated the role that offshore artificial structures may have in linking and affecting biological communities. The study results will inform environmental reviews of conventional energy activities (including decommissioning of platforms) and renewable energy activities (including siting of facilities) offshore southern and central California.

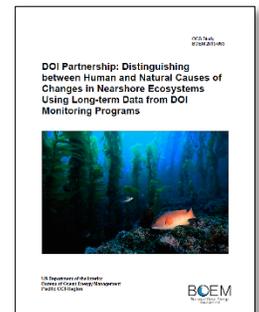
Report (BOEM 2019-001): [https://epis.boem.gov/final%20reports/BOEM\\_2019-001.pdf](https://epis.boem.gov/final%20reports/BOEM_2019-001.pdf)



## **Completed (2019) — DOI Partnership: Distinguishing between Human and Natural Causes of Change in Nearshore Ecosystems Using Long-term Data from DOI Monitoring Programs**

This study by the University of California, Santa Barbara improved understanding about the natural range and sources of variability in the kelp forest ecosystem and generated predictions about how it will respond to environmental change. The findings will enable scientists and managers to evaluate possible impacts from alternative energy production, and develop options to mitigate these impacts.

Report (BOEM 2019-063): [https://epis.boem.gov/final%20reports/BOEM\\_2019-063.pdf](https://epis.boem.gov/final%20reports/BOEM_2019-063.pdf)



## **Completed (2020) — Seabird and Marine Mammal Surveys off the Northern California, Oregon and Washington Coasts**

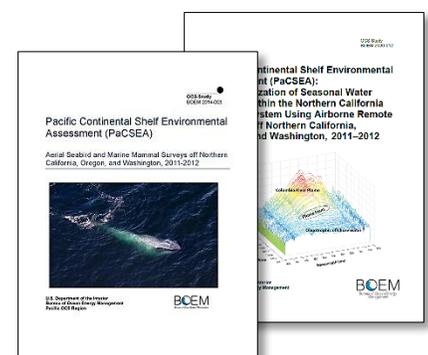
This study by the U.S. Geological Survey and U.S. Fish and Wildlife Service provided up-to-date information on the types, distribution, abundance, seasonal variation, and habitat use of marine mammals and seabirds along the northern California, Oregon, and Washington coasts. Aerial surveys using state-of-the-art technology focused on the most likely areas of OCS renewable energy development. Additional work determined ecosystem connections and species-habitat associations.

First Report (BOEM 2014-003): <https://epis.boem.gov/final%20reports/5427.pdf>

Second Report (BOEM 2020-012):

[https://epis.boem.gov/final%20reports/BOEM\\_2020-012.pdf](https://epis.boem.gov/final%20reports/BOEM_2020-012.pdf)

Webinar: <https://www.boem.gov/Science-Exchange-1/>



### **Completed (2020) — Cross-Shelf Habitat Suitability Modeling**

This study by the National Oceanic and Atmospheric Administration and Oregon State University created two new habitat suitability models for deep water corals, sponges, and soft-sediment macrofaunal species offshore the U.S. West Coast. These habitat suitability models extend across the continental shelf and out to 1200 meter depth. This study included field validations and comparisons with previous models, and improves the predictive capabilities of important seafloor habitats and benthic communities.

First Report (BOEM 2020-008):

[https://espis.boem.gov/final%20reports/BOEM\\_2020-008.pdf](https://espis.boem.gov/final%20reports/BOEM_2020-008.pdf)

Second Report (BOEM 2020-021):

[https://espis.boem.gov/final%20reports/BOEM\\_2020-021.pdf](https://espis.boem.gov/final%20reports/BOEM_2020-021.pdf)



### **Completed (2021) — Pacific Marine Assessment Partnership for Protected Species (PacMAPPS) – California Current**

This study was a partnership between BOEM, the National Marine Fisheries Service, and the U.S. Navy to conduct shipboard surveys of marine mammals, seabirds, and, to the extent possible, sea turtles in the Pacific. The data collected during a 2018 survey of the California Current Ecosystem (Baja California, California, Oregon, and Washington) will help BOEM evaluate potential effects of proposed energy activities on protected species, that includes an ecosystem-level context, including in areas of interest for renewable energy development (California, Oregon) and for conventional energy decommissioning (California).

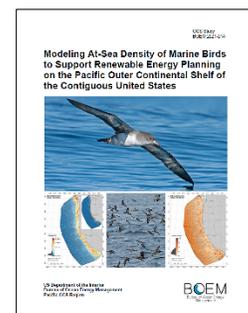
Report (BOEM 2021-013): [https://espis.boem.gov/final%20reports/BOEM\\_2021-013.pdf](https://espis.boem.gov/final%20reports/BOEM_2021-013.pdf)



### **Completed (2021) — Data Synthesis and High-resolution Predictive Modeling of Marine Bird Spatial Distributions on the Pacific OCS**

This study by the National Oceanic and Atmospheric Administration and U.S. Geological Survey synthesized 50 years of seabird survey data off California, Oregon, and Washington, and combined it with information about environmental and oceanographic conditions to predict the occurrence and abundance of seabirds at sea. The resulting predictive maps of seabird distributions will provide critical information for renewable energy siting and evaluation of potential environmental effects of management actions and project approvals.

Report (BOEM 2021-014): [https://espis.boem.gov/final%20reports/BOEM\\_2021-014.pdf](https://espis.boem.gov/final%20reports/BOEM_2021-014.pdf)



### **Completed (2021) — California Deepwater Investigations and Groundtruthing (Cal DIG) I**

This study by the U.S. Geological Survey was a partnership with BOEM, National Oceanic and Atmospheric Administration, and Monterey Bay Aquarium Research Institute. Together they completed eight cruises collecting geophysical, geotechnical, and video data offshore central California in water depths of 400 to 1500 meters. Surveys looked at pockmarks, microdepressions, Santa Lucia Bank, and multiple sand channels. The results include regional geohazards interpretations, habitat classifications, and the first regional characterization of benthic biological communities at these depths. Findings will inform decisions about potential wind turbine siting and future site-specific geohazard and biological analyses in the region.

First Report (BOEM 2021-037): [https://espis.boem.gov/final%20reports/BOEM\\_2021-037.pdf](https://espis.boem.gov/final%20reports/BOEM_2021-037.pdf)

Second Report (BOEM 2021-044): [https://espis.boem.gov/final%20reports/BOEM\\_2021-044.pdf](https://espis.boem.gov/final%20reports/BOEM_2021-044.pdf)

Third Report (USGS Open-File Report and BOEM 2021-045): in press



# Cultural & Archaeological Studies

## Ongoing (2021–2024) — West Coast Tribal Cultural Landscapes

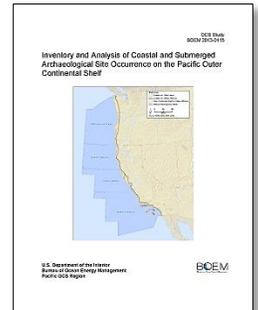
This effort by the Udall Foundation’s John S. McCain III National Center for Environmental Conflict Resolution will work with interested West Coast Tribal Nations to develop cultural landscape assessments along the coast and offshore California and Oregon near areas of potential offshore wind energy development. It will improve understanding about cultural and archaeological resources and places of importance, and assist in understanding potential impacts of offshore renewable energy development.

Study Profile: <https://www.boem.gov/pc-21-01>

## Completed (2013) — Inventory and Analysis of Coastal and Submerged Archaeological Site Occurrence on the Pacific OCS

This study by ICF International assessed the potential for submerged prehistoric sites on the California, Oregon, and Washington Outer Continental Shelf (OCS), and identified coastal properties and significant coastal cultural resources subject to potential visual impacts from offshore energy development. It also produced a proprietary inventory of known, reported, and potential historic shipwrecks.

Report (BOEM 2013-0115): <https://epis.boem.gov/final%20reports/5357.pdf>



## Completed (2017) — Characterizing Tribal Cultural Landscapes

This effort, led by the National Oceanic and Atmospheric Administration, collaborated with the Yurok Tribe of California, Grand Ronde Tribe of Oregon, and Makah Tribe of Washington to develop best practices for consultation through implementation of a cultural landscape approach. Each Tribe employed this approach to develop their own unique case studies. This information will likely be important to future consideration of marine renewable energy projects.

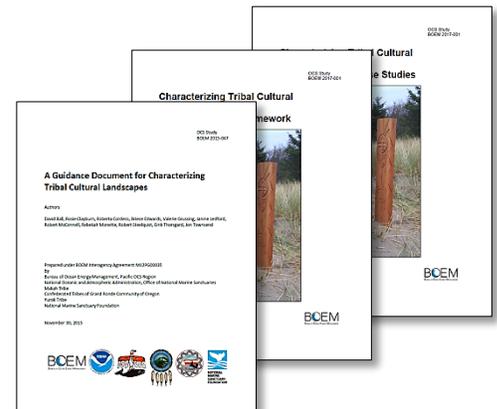
Guidance Document (BOEM 2015-047): <https://www.boem.gov/2015-047/>

Report (BOEM 2017-001):

Volume I: <https://www.boem.gov/BOEM-2017-001-Volume-1/>

Volume II: <https://www.boem.gov/BOEM-2017-001-Volume-2/>

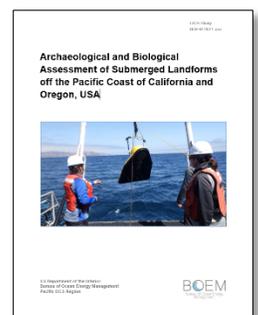
Webinar: <https://www.boem.gov/Science-Exchange-8/>



## Completed (2021) — Archaeological and Biological Assessment of Submerged Landforms off the Pacific Coast of California and Oregon, USA

To better understand the potential for submerged pre-contact archaeological sites on the Pacific OCS, researchers from San Diego State University and a variety of other academic and government institutions employed terrestrial analogues, paleoshoreline mapping, sediment coring, ground-truthing techniques, and biological assessments to explore potential intact submerged geological landforms offshore California’s Northern Channel Islands and central Oregon. This study produced a large dataset and a GIS-based model to predict where intact submerged landforms features may be located on the Pacific OCS.

Report: *in press*

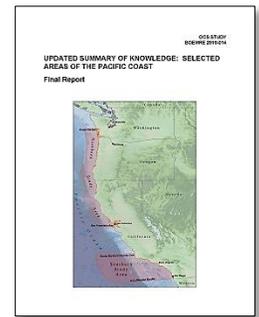


## Information Synthesis Studies

### **Completed (2010) — Updated Summary of Knowledge: Selected Areas of the Pacific Coast**

This study by Mangi Environmental Group compiled and analyzed information generated after 1977 about the coastal and marine environment from Grays Harbor, Washington to San Francisco Bay, and from Santa Barbara County to the U.S.-Mexico border. It identified early information and data gaps about oceanographic resources and potential impacts of offshore renewable energy development.

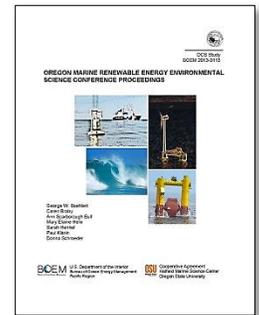
Report (BOEMRE 2010-014): <https://espis.boem.gov/final%20reports/4955.pdf>



### **Completed (2013) — Oregon Marine Renewable Energy Environmental Science Conference**

This conference – coordinated by and held at Oregon State University, Corvallis – brought together an international group (including 40 Oregon specialists) to review existing and ongoing science pertinent to marine renewable energy. This expert group reviewed existing research and prioritized data gaps and needs for baseline conditions, environmental effects, and monitoring studies.

Report (BOEM 2013-0113): <https://espis.boem.gov/final%20reports/5255.pdf>



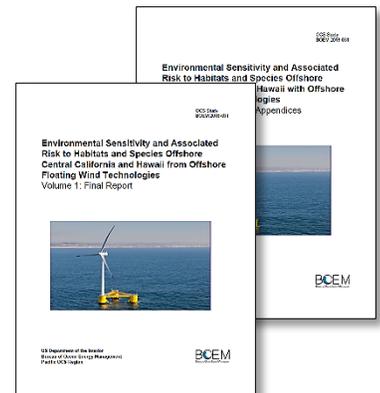
### **Completed (2018) — Environmental Sensitivity and Associated Risk to Habitats and Species Offshore Central California and Hawaii from Offshore Floating Wind Technologies**

This study by ICF International identified and characterized potential impact-causing factors to the marine environment related to offshore floating wind energy development. The study developed an environmental sensitivity and relative risk model to assess impacts on biological and habitat resources from offshore floating wind technology.

Report (BOEM 2018-031):

Volume 1: [https://espis.boem.gov/final%20reports/BOEM\\_2018-031.pdf](https://espis.boem.gov/final%20reports/BOEM_2018-031.pdf)

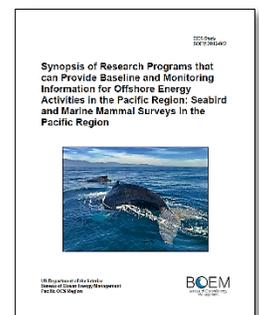
Volume 2: [https://espis.boem.gov/final%20reports/BOEM\\_2018-031\\_A.pdf](https://espis.boem.gov/final%20reports/BOEM_2018-031_A.pdf)



### **Completed (2019) — Synopsis of Research Programs that can Provide Baseline and Monitoring Information for Offshore Energy Activities in the Pacific Region**

This study by the U.S. Geological Survey identified research programs that have produced databases containing information on species and habitats sensitive to offshore energy activities in the Pacific Region. It evaluated the capability of these programs to provide baseline and monitoring data to understand and mitigate potential impacts of conventional energy development offshore southern California and renewable energy development offshore southern California, Oregon, Washington, and Hawaii.

Report (BOEM 2019-042): <https://www.boem.gov/2019-042/>



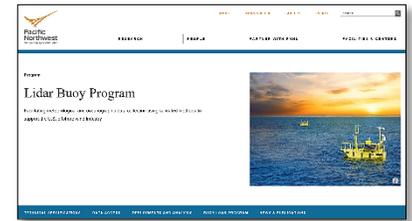
# Physical Oceanography & Geology Studies

## Ongoing (2017-2022) — Collection of Metocean Resource Characterization Data off the California Coast

This study is a partnership between BOEM and the U.S. Department of Energy in which the Pacific Northwest National Laboratory (PNNL) is collecting information about meteorological and oceanographic conditions offshore California using buoys deployed for 12 months. Buoy instrumentation will measure wind speed and direction up to 250 meters above the ocean surface, wave height and direction, currents, salinity, and water and air temperature. Additionally, a Thermal Tracker for detecting birds and bats is being tested on one of the buoys. The collected data will increase understanding of wind and wave energy resources.

Study Profile: <https://www.boem.gov/pr-17-met/>

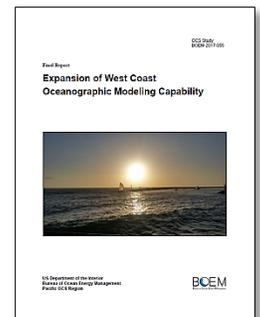
PNNL Buoy Website: <https://www.pnnl.gov/projects/lidar-buoy-program>



## Completed (2017) — Expansion of West Coast Oceanographic Modeling Capability

This study by the University of California, Los Angeles developed a multi-year hindcast (re-analysis) of winds, waves, and currents along the coast of California. The high-resolution (1 km) ROMS hindcast is for the ten-year period 2004–2013 and extends from the U.S.-Mexico border to south of Monterey Bay.

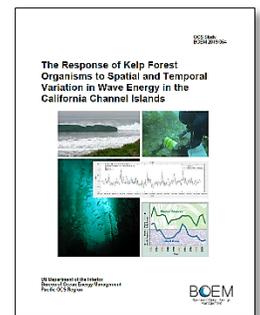
Report (BOEM 2017-055): <https://espis.boem.gov/final%20reports/5636.pdf>



## Completed (2019) — Predicting the Consequences of Wave Energy Absorption from Marine Renewable Energy Facilities on Nearshore Ecosystems

By calibrating a regional wave model with site-specific wave measurements and site-specific biological data (30+ year time series from the National Park Service and the U.S. Geological Survey offshore southern California), this study developed a statistical model to predict the potential effects of wave energy absorption from marine renewable energy facilities on nearshore ecosystems, especially giant kelp forests. The study found that wave energy had a significant effect on several species. But for most taxa (36/57), density was unrelated to waves. Even for those species with a statistical relationship between density and wave energy, a 15% reduction in wave height would not have a detectable effect on the density of any species.

Report (BOEM 2019-064): [https://espis.boem.gov/final%20reports/BOEM\\_2019-064.pdf](https://espis.boem.gov/final%20reports/BOEM_2019-064.pdf)

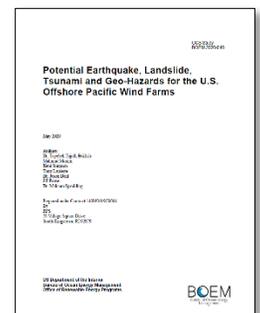


## Completed (2020) — Potential Earthquake, Landslide, Tsunami and Geo-Hazards on the U.S. Offshore Pacific Wind Farms

Floating offshore wind (FOW) construction and operation on the U.S. West Coast may face the risk of potential geohazards, as they are relatively new applications of older technologies (land-based wind and mobile offshore drilling units) in tectonically active regions. Seismic activities, landslides, and tsunamigenic earthquakes are threats to the U.S. West Coast and Hawaii, and uncertainty exists over how FOW development and siting will be impacted by these threats in proposed areas of development. This study provided both a general evaluation of geohazards for floating wind areas already designated as potential lease sites and developed design considerations and criteria for structures to cope with extreme events.

Report (BOEM 2020-040): <https://www.boem.gov/environment/final-report-geohazards>

Web Map Interface: <http://boem-oceansmap.s3-website-us-east-1.amazonaws.com/>



# Resource, Technology & Infrastructure Studies

## Ongoing (2016-2022) — Scenarios for Offshore Renewable Energy along the Central California Coast

This study by California Polytechnic State University, San Luis Obispo is delineating feasible offshore renewable energy scenarios along the central coast of California. Researchers will determine information needs and evaluate scenarios, tradeoffs, and generating capacity of various facilities as well as information needed to conduct environmental reviews.

Study Profile: <https://www.boem.gov/pc-16-01/>

Journal Article: <https://www.sciencedirect.com/science/article/pii/S096456912100096X>



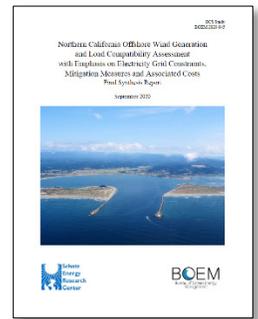
## Ongoing (2019-2022) — Offshore Wind Generation and Load Compatibility Assessment with Emphasis on Electricity Grid Constraints, Mitigation Measures and Associated Costs

This study by Humboldt State University is assessing the feasibility, scale, and transmission options of offshore wind power generation along the coast of northern California. It is characterizing the electrical transmission grid system and identifying constraints, mitigations, modifications, and costs to the grid to accommodate offshore wind energy production and transmission.

Study Profile: <https://www.boem.gov/pr-19-hsu/>

First Report: <https://www.boem.gov/BOEM-2020-045>

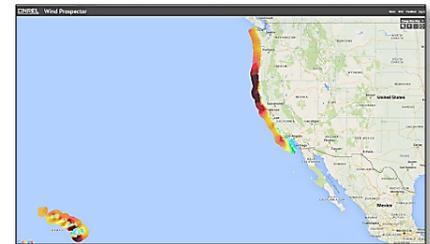
Additional Reports: in press



## Completed (2015) — Pacific Offshore Time Series Wind Resource Analysis

This study by the U.S. Department of Energy/National Renewable Energy Laboratory (NREL) addressed time-series analysis of wind speed data along the coasts of Washington, Oregon, California, and Hawaii, scaled to BOEM's aliquot grid (a unit of leasing). Average wind speed is provided by month, by hours of the day, and for a long-term (17-year) time series. Data are available through Wind Prospector, NREL's web-based GIS application, which provides easy access to wind resource datasets and supports resource assessment and exploration associated with wind development.

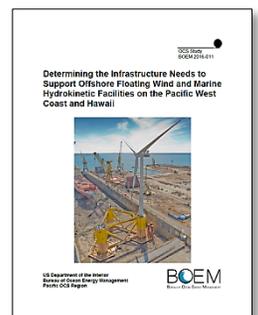
Data: <https://maps.nrel.gov/wind-prospector/>



## Completed (2016) — Determining the Infrastructure Needs to Support Offshore Floating Wind and Marine Hydrokinetic Facilities on the Pacific West Coast and Hawaii

This study by ICF International evaluated the current infrastructure and vessel requirements and capabilities existing on the Pacific West Coast of the U.S. and the Hawaiian islands of Oahu, Maui, and Kauai to support the burgeoning offshore renewable energy industry. Understanding the infrastructure needs of the offshore renewable industry will help to identify the port-related requirements for offshore floating wind development and marine hydrokinetic industries and assess the utilization of the available marine equipment and facilities along the U.S. West Coast.

Report (BOEM 2016-011): <https://espis.boem.gov/final%20reports/5503.pdf>

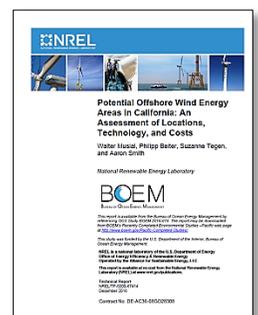


## Completed (2016) — Potential Offshore Wind Energy Areas in California: An Assessment of Locations, Technology, and Costs

This study by the U.S. Department of Energy/National Renewable Energy Laboratory developed unsubsidized cost estimates for offshore wind power in the State of California. The cost estimates were calculated for six reference sites that were selected based on physical site conditions, wind resource quality, known existing site use, and proximity to necessary infrastructure. The analyses showed significant cost-reduction potential over the target time period (2015 to 2030). The results can be used to assist decision-making by state utilities, independent system operators, government officials and policy makers, and stakeholders. (Note: An updated cost study was completed in 2020; see Cost of Floating Offshore Wind Energy in California Between 2019 and 2032.)

Report (BOEM 2016-074): <https://www.boem.gov/2016-074/>

Cost Estimates: <https://www.boem.gov/Spreadsheet-for-CA-Offshore-Wind-Cost-Estimates/>

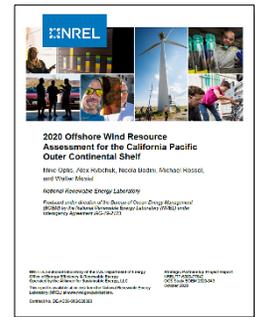


## Completed (2020) — 2020 Offshore Wind Resource Assessment for the California Pacific Outer Continental Shelf

This study by the U.S. Department of Energy/National Renewable Energy Laboratory developed an updated, state-of-the-art wind resource data set for the Outer Continental Shelf off the coast of California. It found higher mean wind speeds modeled in the new data set compared to the previous data set. The increase in the modeled wind resource will impact economic and energy modeling and planning for offshore wind.

Report (BOEM 2020-043): <https://www.boem.gov/BOEM-2020-043>

Summary Presentation: <https://www.boem.gov/BOEM-2020-043-Presentation>



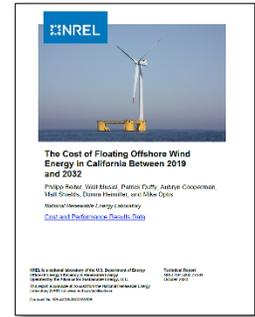
## Completed (2020) — Cost of Floating Offshore Wind Energy in California Between 2019 and 2032

This study by the U.S. Department of Energy/National Renewable Energy Laboratory, in coordination with the California Public Utilities Commission, developed site-specific cost and performance estimates for floating wind energy offshore California. The detailed analysis focused on five Outer Continental Shelf areas where commercial-scale offshore wind projects are under consideration: Morro Bay, Diablo Canyon, Humboldt, Cape Mendocino, and Del Norte.

Report (BOEM 2020-048): <https://www.boem.gov/BOEM-2020-048>

Cost and Performance Results Data: <https://www.boem.gov/BOEM-2020-048-data>

Summary Presentation: <https://www.boem.gov/BOEM-2020-048-Presentation>



## Socioeconomic Studies

### Ongoing (2021–2023) — Using Outcomes from Marine Protected Area Implementation to Infer Potential Socioeconomic Consequences of Offshore Energy Development to Commercial Fisheries

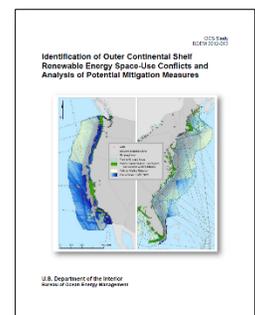
This study by the University of California, Santa Barbara will describe the detectable socioeconomic consequences experienced by the commercial fishing industry due to the implementation of formal or de facto marine protected areas (MPAs) in California. This information will inform impact analyses of prospective offshore energy projects and decommissioning decisions.

Study Profile: <https://www.boem.gov/pc-21-02>

### Completed (2012) — Identification of Outer Continental Shelf Renewable Energy Space-Use Conflicts and Analysis of Potential Mitigation Measures

This study by Industrial Economics, Incorporated captured baseline space-use information on the Atlantic and Pacific Coasts; the Pacific study area included federal waters offshore Washington, Oregon, and northern California. It collected data on more than a dozen space uses (including commercial fishing and shipping), identified potential and known conflicts that may arise with renewable energy development, and provided insights on potential mitigation and avoidance measures.

Report (BOEM 2012-083): <https://espis.boem.gov/final%20reports/5203.pdf>

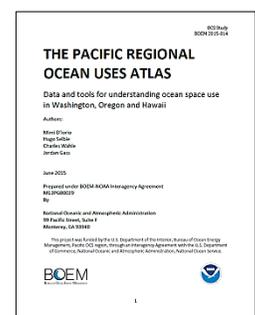


### Completed (2015) — Pacific Regional Ocean Uses Atlas

This partnership between BOEM and the National Oceanic and Atmospheric Administration documented patterns of existing and emerging ocean uses in OCS areas off the states of Washington, Oregon, and Hawaii through participatory mapping workshops. The project also identified potential areas of conflict and/or compatibility between proposed renewable energy areas and other ocean uses. The atlas documents a full range of human activities and sectors in the ocean to support offshore renewable energy planning.

Report (BOEM 2015-014): <https://www.boem.gov/2015-014/>

Project Information: <https://marinecadastre.gov/oceanuses/>

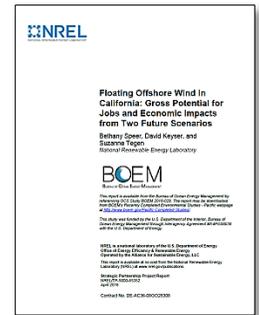


## Completed (2016) — Floating Offshore Wind in California: Gross Potential for Jobs and Economic Impacts from Two Future Scenarios

This study by the U.S. Department of Energy/National Renewable Energy Laboratory conducted an analysis of the employment and economic potential for floating offshore wind in California. The study examined two scenarios: 16 GW of offshore wind by 2050 and 10 GW of offshore wind by 2050. The results of this analysis can be used to better understand the general scales of economic opportunities that could result from offshore wind development.

Report (BOEM 2016-029): <https://www.boem.gov/2016-029/>

Jobs and Economic Development Impact Wind Models Website: <https://www.nrel.gov/analysis/jedi/wind.html>



## Other Studies Informing OCS Renewable Energy (not specific to California)

- BOEM 2013-0116 Evaluation of Lighting Schemes for Offshore Wind Facilities and Impacts to Local Environments**  
(<https://epis.boem.gov/final%20reports/5298.pdf>)
- BOEM 2016-002 Development of Guidance for Lighting of Offshore Wind Turbines Beyond 12 Nautical Miles**  
(<https://www.boem.gov/offshore-lighting-guidance/>)
- BOEM 2017-057 Phased Approaches to Offshore Wind Development and Use of the Project Design Envelope**  
(<https://www.boem.gov/Phased-Approaches-to-Offshore-Wind-Developments-and-Use-of-Project-Design-Envelope/>)
- BOEM 2018-053 Impact Assessment and Mitigation of Offshore Wind Turbines on High Frequency Coastal Oceanographic Radar** ([https://epis.boem.gov/final%20reports/BOEM\\_2018-053.pdf](https://epis.boem.gov/final%20reports/BOEM_2018-053.pdf))
- BOEM 2018-057 Metocean Characterization Recommended Practices for U.S. Offshore Wind Energy**  
(<https://www.boem.gov/Metocean-Recommended-Practices/>)
- BOEM 2020-039 Radar Interference Analysis for Renewable Energy Facilities on the Atlantic Outer Continental Shelf**  
(<https://www.boem.gov/environment/radar-interference-atlantic-offshore-wind0pdf>)
- BOEM 2021-030 Floating Offshore Wind Turbine Development Assessment** (<https://www.boem.gov/renewable-energy/studies/study-number-deliverable-4-final-report-technical-summary>)
- BOEM 2021-032 Assessment of Seascape, Landscape, and Visual Impacts of Offshore Wind Energy Developments on the Outer Continental Shelf of the United States**  
(<https://www.boem.gov/environment/environmental-studies/boem-2021-032>)
- BOEM 2021-053 Comparison of Environmental Effects from Different Offshore Wind Turbine Foundations**  
(<https://www.boem.gov/environment/wind-turbine-foundations-white-paper-final-white-paper>)

### For more information about BOEM-funded research:

**Environmental Studies Program:** <https://www.boem.gov/Studies/>

**Pacific OCS Environmental Studies:** <https://www.boem.gov/Pacific-Studies/>

**Environmental Studies Program Information System (ESPIS):** <https://marinecadastre.gov/epis/#/>

**Renewable Energy Research:** <https://www.boem.gov/environment/environmental-studies/renewable-energy-research>

**BOEM Activities in California:** <https://www.boem.gov/California>

