BOEM
Bureau of Ocean Energy Management

Selected BOEM-Funded Research Informing Renewable Energy Offshore California
AUGUST 2023

NEW ▷ Indicates a recently started or recently completed study.

Biological Studies

Ongoing (2017–2023) — **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 (2019–2025) — **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 system models will be integrated into simulations to visualize various potential interaction scenarios, including considering associated derelict fishing gear. The 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/pc-19-x07
Infographic: https://www.boem.gov/pr-19-ent-infographic
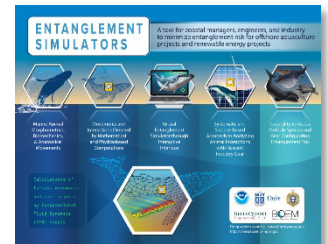
Ongoing (2019-2023) — **California Deepwater Investigations and Groundtruthing (Cal DIG) II**
This study is a partnership between BOEM, National Oceanic and Atmospheric Administration, and U.S. Geological Survey to map geologic features and characterize seafloor habitats offshore California and Oregon. 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

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 off the Pacific coast.
Study Profile: https://www.boem.gov/pc-20-01-profile

Ongoing (2020–2024) — **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 Areas offshore northern and central California and in a pilot study area offshore Oregon (likely in the vicinity of the Brookings Call Area for wind energy). 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 (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 (2022–2026) — **Birds, Bats, and Beyond: Networked Wildlife Tracking along the Pacific Coast of the U.S.**
This study by the U.S. Geological Survey will support the expansion of the Motus wildlife tracking network and other networked wildlife tracking along the Pacific coast to elucidate the timing and scale of movements for marine birds and migratory bats in relation to offshore energy and other coastal development projects. The initial BOEM-funded effort will be offshore southern California, with possible subsequent expansion to other areas of the Pacific Coast.
Study Profile: https://www.boem.gov/pc-22-03

Ongoing (2022–2026) — **Baseline Data Collection on Cetaceans and Seabirds in the Outer Continental Shelf and Slope of Northern California and Oregon to Inform Offshore Wind Energy Development**
This BOEM and U.S. Department of Energy (DOE)-funded study, which is being conducted by Oregon State University and managed by DOE, will conduct visual surveys and acoustic monitoring of marine mammals and seabirds to develop predictive density maps of species present in potential wind energy development areas offshore northern California and Oregon.
Website: https://www.energy.gov/articles/doe-announces-135-million-sustainable-development-offshore-wind

Ongoing (2022–2024) — **Tag you're it! Habitat Use of Whales of the U.S. West Coast and Hawai'i**
This study by Oregon State University and the U.S. Navy will collate and analyze existing whale telemetry data to identify residence times, home ranges, seasonal shifts, hot spots of aggregation, and dive profiles of large whale species to better understand habitat usage. The first phase will focus on the Santa Barbara Channel and areas offshore Hawai'i (specifically around the island of O'ahu). The information garnered about whale occurrence, movements, and behavior will help inform decisions about the siting of offshore floating wind development offshore California and Hawai'i, and the timing of conventional energy decommissioning activities offshore southern California.
Study Profile: https://www.boem.gov/pc-22-04

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://espis.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://espis.boem.gov/final%20reports/5115.pdf*
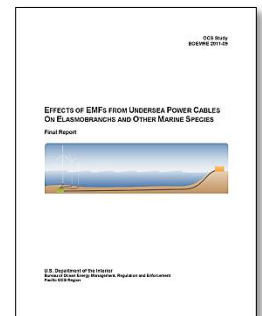
Completed (2012) — **West Coast Environmental Protocols Framework: Baseline and Monitoring Studies**
This study by Pacific Energy Ventures provides a framework for identifying natural resources and ecological issues to monitor for proposed wave, tidal, and offshore wind projects along the U.S. West Coast.
Report BOEM 2012-013: https://espis.boem.gov/final%20reports/5219.pdf
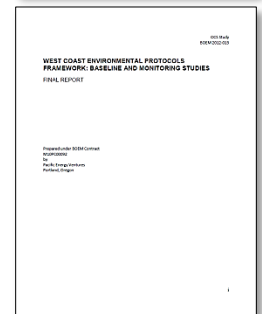
Completed (2014) — **Survey of Benthic Communities Near Potential Renewable Energy Sites Offshore the Pacific Northwest**
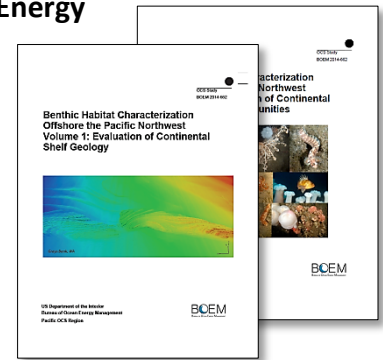
This study by Oregon State University provided baseline information about the seafloor environment and the types and distribution of benthic invertebrates in areas of potential renewable energy development on the Washington, Oregon, and northern California OCS. Knowledge of species-habitat relationships will allow for prediction of seafloor communities beyond those sampled in this study.

Report BOEM 2014-662:
Volume 1: https://espis.boem.gov/final%20reports/5453.pdf
Volume 2: https://espis.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://espis.boem.gov/final%20reports/5520.pdf*
Webinar: https://www.boem.gov/Science-Exchange-3
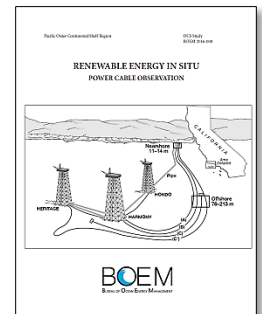
Completed (2016) — **Using Ongoing Activities as Surrogates to Predict Potential Ecological Impacts from Marine Renewable Energy**

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.

Reports:
BOEM 2015-021: *https://www.boem.gov/2015-021*
BOEM 2015-042: *https://www.boem.gov/2015-042*
BOEM 2016-041: *https://www.boem.gov/2016-041*
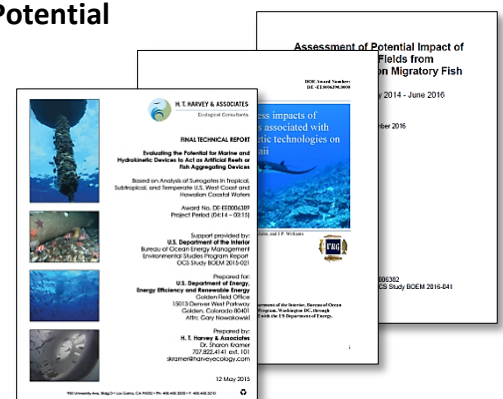
Completed (2016) — **Developing and Applying a Vulnerability Index for Scaling the Possible Adverse Effects of Offshore Renewable Energy Projects on Seabirds on the Pacific OCS**

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* BOEM 2016-043 (USGS Open-File Report 2016-1154): *https://pubs.er.usgs.gov/publication/ofr20161154*
Webinar: https://www.boem.gov/Science-Exchange-6
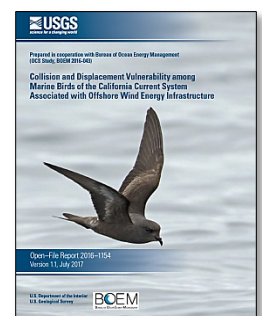
Completed (2018) — **California Current Cetacean and Ecosystem Assessment Survey and Use of Data to Produce and Validate Cetacean and Seabird Density Maps**
This study by the National Oceanic and Atmospheric Administration's National Marine Fisheries Service Southwest Fisheries Science Center focused on listening for whale species that are difficult to detect during visual surveys because of their deep diving habits and and limited surface activity.
<u>Report</u> *BOEM 2018-025: https://espis.boem.gov/final%20reports/BOEM_2018-025.pdf*
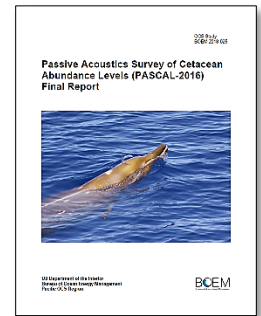

Completed (2018) — **Humpback Whale Encounter with Offshore Wind Mooring Lines and Inter-Array Cables**
This study by the U.S. Department of Energy's Pacific Northwest National Laboratory compiled information about whale movements (e.g., dive depths and swimming speed) and created a three-dimensional 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.
<u>Report</u> *BOEM 2018-065: https://www.boem.gov/BOEM-2018-065*
<u>Video Animation</u>: *https://www.boem.gov/humpback-whales-floating-wind*
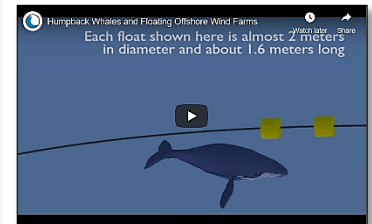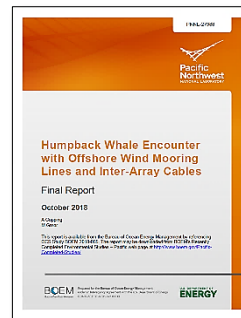
Completed (2019) — **Understanding the Role of Offshore Structures in Managing Potential *Watersipora subtorquata* Invasions**
This study by the University of California, Santa Barbara surveyed the distribution and abundance of a non-native bryozoan on 23 platforms and natural reefs in the Southern California 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.
<u>Report</u> *BOEM 2019-001: https://espis.boem.gov/final%20reports/BOEM_2019-001.pdf*
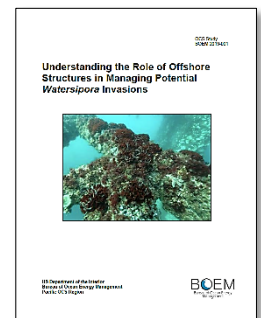
Completed (2019) — **DOI Partnership: Distinguishing between Human and Natural Causes of Change in Nearshore Ecosystems Using Long-term Data from DOI Monitoring Programs**
This study by the University of California, Santa Barbara improved understanding about the natural range and sources of variability 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.
<u>Report</u> *BOEM 2019-063: https://espis.boem.gov/final%20reports/BOEM_2019-063.pdf*
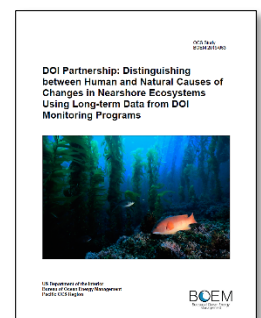
Completed (2020) — **Seabird and Marine Mammal Surveys off the Northern California, Oregon and Washington Coasts**
This study by the U.S. Geological Survey and U.S. Fish and Wildlife Service provided up-to-date information on the types, distribution, abundance, seasonal variation, and habitat use of 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.
<u>Reports:</u>
BOEM 2014-003: https://espis.boem.gov/final%20reports/5427.pdf
BOEM 2020-012: https://espis.boem.gov/final%20reports/BOEM_2020-012.pdf
<u>Webinar</u>: *https://www.boem.gov/Science-Exchange-1*
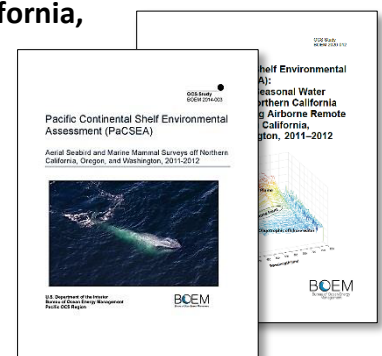
Completed (2020) — **Cross-Shelf Habitat Suitability Modeling**
This study by the National Oceanic and Atmospheric Administration and Oregon State University created two new habitat suitability models for deep water corals, sponges, and soft-sediment macrofaunal species offshore the U.S. West Coast. 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.
Reports:
BOEM 2020-008: https://espis.boem.gov/final%20reports/BOEM_2020-008.pdf
*BOEM 2020-021: https://espis.boem.gov/final%20reports/BOEM_2020-021.pdf*
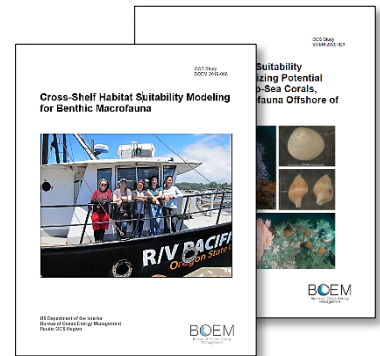
Completed (2021) — **Pacific Marine Assessment Partnership for Protected Species (PacMAPPS)** – **California Current**
This study was a partnership between BOEM, the National Marine Fisheries Service, and the U.S. Navy to conduct shipboard surveys of marine mammals, seabirds, and, to the extent possible, 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*
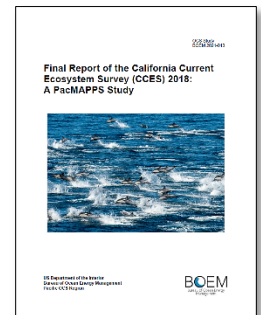
Completed (2021) — **Data Synthesis and High-resolution Predictive Modeling of Marine Bird Spatial Distributions on the Pacific OCS**
This study by the National Oceanic and Atmospheric Administration and U.S. Geological Survey synthesized 50 years of seabird survey data off California, Oregon, and Washington, 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
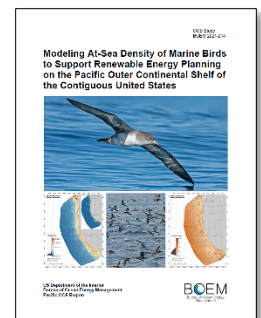
Completed (2022) — **California Deepwater Investigations and Groundtruthing (Cal DIG) I**
This study by the U.S. Geological Survey was a partnership with BOEM, National Oceanic and Atmospheric Administration, and Monterey Bay Aquarium Research Institute. Together they completed eight cruises collecting 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.
Reports:
BOEM 2021-037: https://espis.boem.gov/final%20reports/BOEM_2021-037.pdf
BOEM 2021-044: https://espis.boem.gov/final%20reports/BOEM_2021-044.pdf
BOEM 2021-045 (USGS Open-File Report 2022-035): https://pubs.usgs.gov/of/2022/1035/ofr20221035.pdf

Completed (2022) — **Assessing and Advancing Individual Matching Accuracy of Photographed Gray Whales Using Artificial Intelligence**

This study by Wild Me was conducted 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 focused on increasing the accuracy of these algorithms to match laterally photographed gray whales. Complementing existing efforts funded by the National Oceanic and Atmospheric Administration's National Marine Fisheries Service Southwest Fisheries Science Center, this study aimed 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.

Reports:
BOEM 2021-059: https://www.boem.gov/BOEM-2021-059
*BOEM 2022-064: https://www.boem.gov/BOEM-2022-064*

NEW *Completed (2023) —* **Supplemental Data Regarding the Behavioral Response of Rock Crabs to the EMF of Subsea Cables and Potential Impact to Fisheries**

This study by Occidental College used existing AC subsea cables (34.5 kV) to test whether the electromagnetic field (EMF) produced by power transmission affected the behavior of red rock crabs, a species fished commercially. The presence of a magnetic field did not affect the propensity of crabs to enter baited traps. This effort augmented an earlier study published by the University of California, Santa Barbara with additional experimental evidence.

Report BOEM 2023-005: https://espis.boem.gov/final%20reports/BOEM_2023-005.pdf
*Video: https://www.boem.gov/newsroom/will-crabs-cross-submarine-cables*
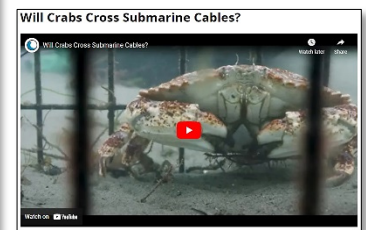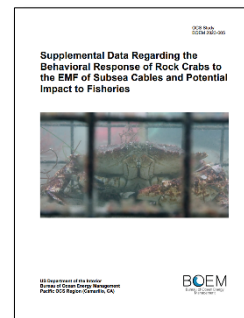
NEW *Completed (2023) —* **A Demonstration Marine Biodiversity Observation Network (BON) for Ecosystem Monitoring**

This study was a partnership between BOEM, University of California, Santa Barbara, National Aeronautics and Space Administration, and other research organizations to improve understanding of marine biodiversity in the Southern California Bight. The findings will assist in environmental impact assessment by characterizing the regional ecology where offshore energy activities occur and by testing advanced methodology, including artificial intelligence and genomics, to assist in biodiversity monitoring.

Report BOEM 2023-030: https://espis.boem.gov/final%20reports/BOEM_2023-030.pdf
Website: https://sbc.marinebon.org
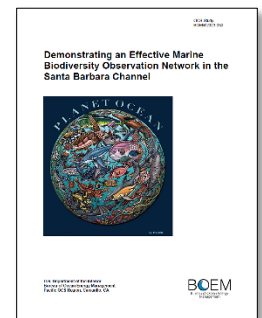
NEW *Completed (2023) —* **A Vulnerability Index to Scale Effects of Offshore Renewable Energy on Marine Mammals and Sea Turtles of the U.S. West Coast (VIMMS)**

This study by Southall Environmental Associates (SEA), Inc. developed 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. The 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 developed 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
Report: in press

Cultural & Archaeological Studies

*Ongoing (2021–2025) —* **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, Oregon, and Washington 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://espis.boem.gov/final%20reports/5357.pdf
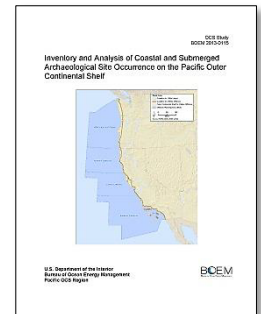
Completed (2017) — **Characterizing Tribal Cultural Landscapes**
This effort, led by the National Oceanic and Atmospheric Administration, collaborated with the Yurok Tribe of California, Grand Ronde Tribe of Oregon, and Makah Tribe of Washington to develop best practices for consultation through implementation 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.
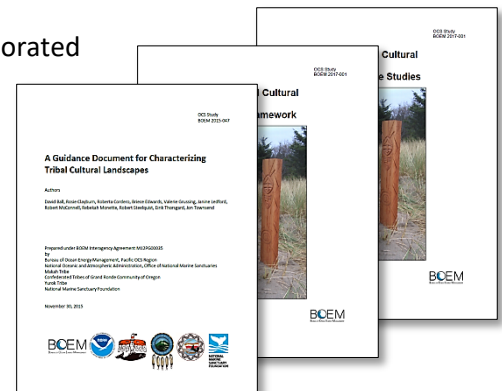*Reports:*
BOEM 2015-047 (Guidance Document): https://www.boem.gov/2015-047
BOEM 2017-001:
Volume I: https://www.boem.gov/BOEM-2017-001-volume-1
Volume II: https://www.boem.gov/BOEM-2017-001-volume-2
*Webinar: https://www.boem.gov/Science-Exchange-8*

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*
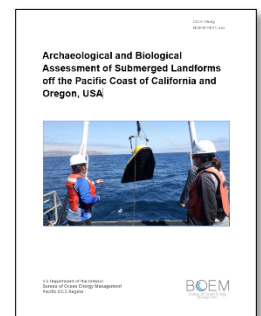
Information Synthesis Studies

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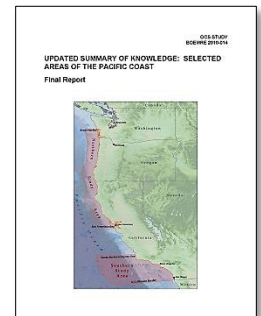
Completed (2013) — **Oregon Marine Renewable Energy Environmental Science Conference**

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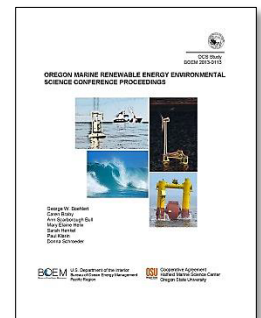
Completed (2018) — **Environmental Sensitivity and Associated Risk to Habitats and Species Offshore Central California and Hawaii from Offshore Floating Wind Technologies**

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
Volume 2: https://espis.boem.gov/final%20reports/BOEM_2018-031_A.pdf
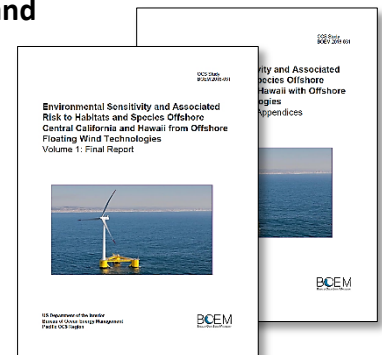
Completed (2019) — **Synopsis of Research Programs that can Provide Baseline and Monitoring Information for Offshore Energy Activities in the Pacific Region**

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
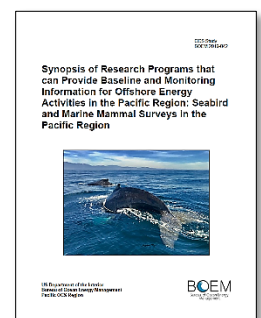
Physical Oceanography & Geology Studies

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.
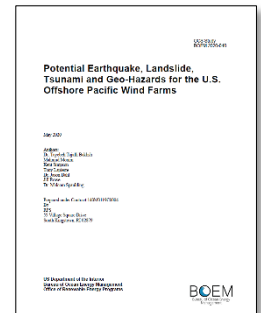
Report BOEM 2017-055: https://espis.boem.gov/final%20reports/5636.pdf
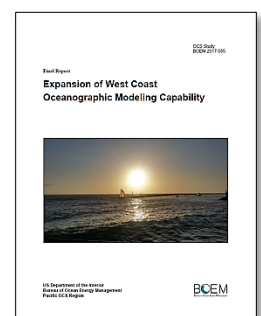
Completed (2019) — **Predicting the Consequences of Wave Energy Absorption from Marine Renewable Energy Facilities on Nearshore Ecosystems**

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.
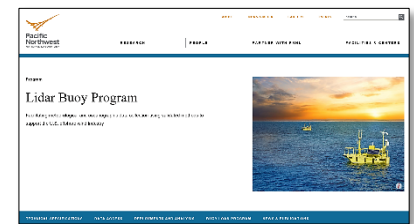*Report* BOEM 2019-064: https://espis.boem.gov/final%20reports/BOEM_2019-064.pdf

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. (Note: An update to this study was developed in 2023; see Geohazard Analysis and Suitability Updates for California Floating Windfarms.)
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

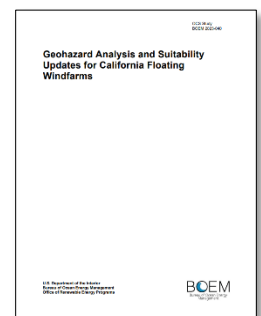**NEW** *Completed (2022) —* **Collection of Metocean Resource Characterization Data off the California Coast**

This study was a partnership between BOEM and the U.S. Department of Energy's Pacific Northwest National Laboratory (PNNL) to collect information about meteorological and oceanographic conditions offshore California using buoys deployed for 12 months. Buoy instrumentation included a doppler lidar for measuring wind speed and direction up to 250 meters above the ocean surface. Additional instruments measured wave height and direction, currents, salinity, and water and air temperature. Additionally, a Thermal Tracker for detecting birds and bats was tested on one of the buoys. The collected data will improve understanding of wind and wave energy resources, and is used by researchers and industry to inform model creation and decision making.
PNNL Lidar Buoy Program Website: https://www.pnnl.gov/projects/lidar-buoy-program

NEW *Completed (2023) —* **Geohazard Analysis and Suitability Updates for California Floating Windfarms**

This study by RPS updated the 2020 study (see Potential Earthquake, Landslide, Tsunami and Geo-Hazards on the U.S. Offshore Pacific Wind Farms) with newly available geophysical and geotechnical data where information was integrated into the geohazard assessment to fill in data gaps and to assess site conditions and geohazards at several locations off the coast of California.
Report BOEM 2023-040: https://www.boem.gov/environment/environmental-studies/bsee-ca-geohazards
Website: https://oceansmap.com/BOEM/California

Resource, Technology & Infrastructure Studies

Ongoing (2016–2024) — **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 (2022–2024) — **West Coast Offshore Wind Power Flows**
This study by the U.S. Department of Energy's Pacific Northwest National Laboratory seeks to identify the constraints and opportunities for Oregon and California offshore wind power to flow to the San Francisco area. Three transmission scenarios will be compared to understand how the interconnection design influences the dispatch of offshore wind and other power plants. The transmission scenarios may include (1) direct, radial interconnection of each offshore wind farm into the land-based grid, (2) a coordinated interconnection process where multiple wind farms use a single interconnection point, or (3) a coordinated subsea HVDC cable that interconnects to the San Francisco Bay Area and potentially other coastal locations.

Completed (2015) — **Pacific Offshore Time Series Wind Resource Analysis**
This study by the U.S. Department of Energy's 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 was provided by month, by hours of the day, and for a long-term (17-year) time series. These and other offshore wind resource datasets are available via the Open Energy Data Initiative.
*Data:* https://dx.doi.org/10.25984/1821404

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
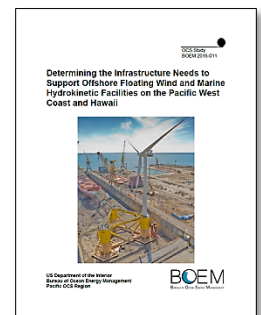
Completed (2016) — **Potential Offshore Wind Energy Areas in California: An Assessment of Locations, Technology, and Costs**
This study by the U.S. Department of Energy's National Renewable Energy Laboratory developed unsubsidized cost estimates for offshore wind power in the State of California. The 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
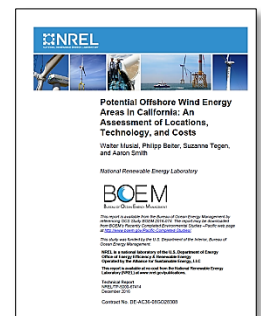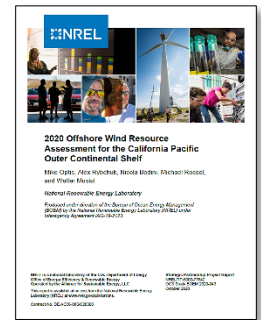
Completed (2020) — **2020 Offshore Wind Resource Assessment for the California Pacific Outer Continental Shelf**

This study by the U.S. Department of Energy's 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. (Note: An update to the ongoing analysis of this data set was developed in 2022; see Update on NREL's 2020 Offshore Wind Resource Assessment for the California Pacific Outer Continental Shelf.)

Report BOEM 2020-043: https://www.boem.gov/BOEM-2020-043
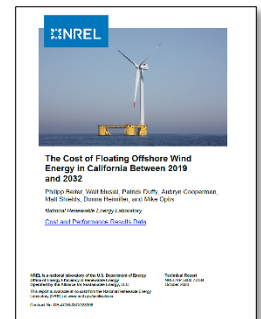*Summary Presentation: https://www.boem.gov/BOEM-2020-043-Presentation*

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

This study by the U.S. Department of Energy's 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

Completed (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 assessed the feasibility, scale, and transmission options of offshore wind power generation along the coast of northern California. It characterized the electrical transmission grid system and identifying constraints, mitigations, modifications, and costs to the grid to accommodate offshore wind energy production and transmission.

Reports:
BOEM 2020-045: https://www.boem.gov/BOEM-2020-045
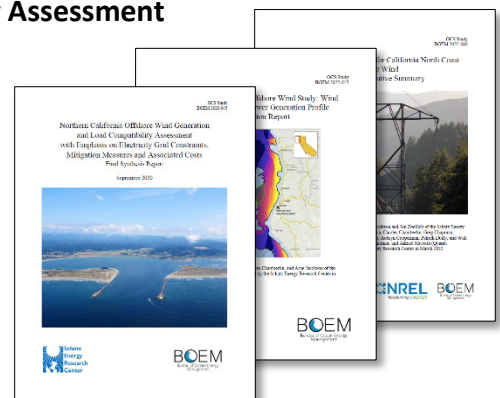*BOEM 2022-015: https://www.boem.gov/BOEM-2022-015*
BOEM 2022-016:
Volume 1: https://www.boem.gov/BOEM-2022-016-vol1
Volume 2: https://www.boem.gov/BOEM-2022-016-vol2
Volume 3: https://www.boem.gov/BOEM-2022-016-vol3
Volume 4: https://www.boem.gov/BOEM-2022-016-vol4
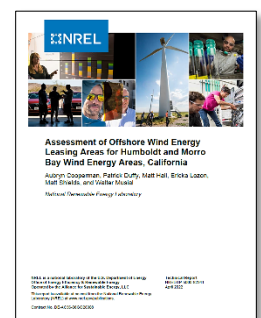
Completed (2022) — **Assessment of Offshore Wind Energy Leasing Areas for Humboldt and Morro Bay Wind Energy Areas, California**

This study by the U.S. Department of Energy's National Renewable Energy Laboratory assessed several options for delineating potential lease areas for the Humboldt and Morro Bay Wind Energy Areas offshore California. The analysis included physical site characteristics and their effects on technology selection and energy generating potential.

Report BOEM 2022-025: https://www.boem.gov/BOEM-2022-025

Completed (2022) — **Update on NREL's 2020 Offshore Wind Resource Assessment for the California Pacific Outer Continental Shelf**

This study by the U.S. Department of Energy's National Renewable Energy Laboratory (NREL) provides an update to the ongoing analysis of the 20-year wind resource data set (named "CA20") that NREL produced in 2020 for the Outer Continental Shelf (OCS) offshore California (see 2020 Offshore Wind Resource Assessment for the California Pacific Outer Continental Shelf). Previous analysis indicated a larger-than-expected bias between the CA20 wind model and observations from two floating lidar buoys deployed in the California OCS. The report summarizes NREL's current understanding of the cause of the bias and describes the continuing efforts underway to create a more accurate wind model for the California OCS in 2023.
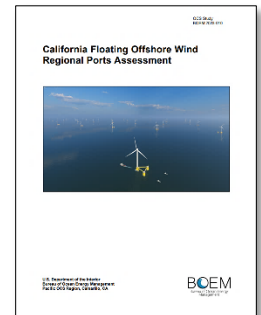
Report BOEM 2022-072: https://www.boem.gov/BOEM-2022-072

NEW › *Completed (2023) —* **California Floating Offshore Wind Regional Ports Assessment**

This study by Moffatt & Nichol analyzed the current and planned infrastructure of California ports to assess their ability to support the growing floating offshore wind industry's demand. It used spatial analysis, interviews, and available records to collect the necessary data regarding infrastructure readiness. The findings culminated in a report that outlines port requirements and deployment scenarios to support the industry and a basis of analysis with which Moffat & Nichol will conduct a regional feasibility analysis of existing and planned port facilities and infrastructure (see California Floating Offshore Wind Regional Ports Feasibility Analysis).

Report BOEM 2023-010: https://www.boem.gov/BOEM-2023-010

NEW › *Completed (2023) —* **California Floating Offshore Wind Regional Ports Feasibility Analysis**

This study by Moffat & Nichol built upon the completed California Floating Offshore Wind Regional Ports Assessment. The study further evaluated the feasibility of improvements for California port sites identified in the previous Assessment. This further evaluation includes cost estimates and project development timelines for the port infrastructure improvements needed for offshore wind industry use.

Report BOEM 2023-038: https://www.boem.gov/BOEM-2023-038
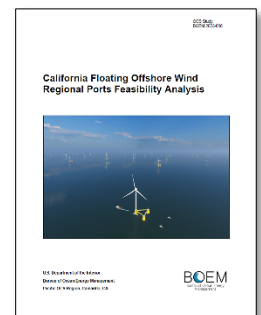
Socioeconomic Studies

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

Ongoing (2022–2023) — **Socioeconomic Characterization of West Coast Fisheries in Relation to Offshore Wind Development**
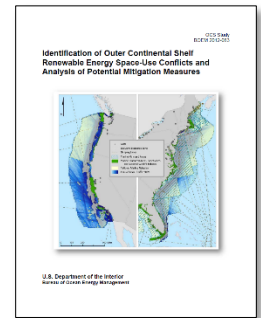
This study by the National Oceanic and Atmospheric Administration's National Marine Fisheries Service Northwest Fisheries Science Center is developing products that will help BOEM characterize West Coast fishing communities, including supportive industries (primary and secondary/ancillary markets), fishing-related infrastructure, fishing sector interconnections, and potential connections between fishing sectors and wind energy development offshore the West Coast. This information will further BOEM's understanding of West Coast fisheries; it will also be used to support NEPA and other analyses, and inform BOEM's decision-making throughout its planning process and construction and operation of offshore wind on the West Coast.

Study Profile: https://www.boem.gov/pr-22-soc

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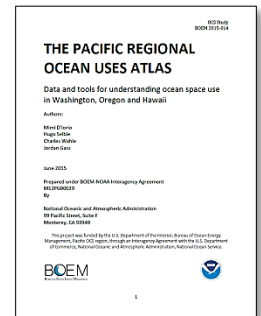
Completed (2016) — **Floating Offshore Wind in California: Gross Potential for Jobs and Economic Impacts from Two Future Scenarios**

This study by the U.S. Department of Energy's 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
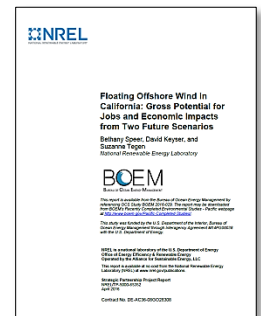
Other Studies Informing OCS Renewable Energy (not specific to California)

BOEM 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://espis.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-interferance-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

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For more information about BOEM-funded research:

Environmental Studies Program: https://www.boem.gov/environment/how-we-do-research

Environmental Studies Program Hub: https://www.boem.gov/environment/environmental-studies/environmental-studies-information

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

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

BOEM Activities in California: https://www.boem.gov/California

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