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NEW Indicates a recently started study.

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 (2016–2022) — Analysis of Long-term Seabird Colony Legacy Data in the Pacific Northwest as a Regional Baseline

This study by the U.S. Fish and Wildlife Service is summarizing data regarding the abundance and distribution of birds in seabird breeding colonies along the coasts of Oregon and Washington. It will provide an environmental baseline against which to evaluate potential effects of offshore energy projects on seabird colonies and populations.

Study Profile: <https://www.boem.gov/pc-16-06>

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 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/pc-19-x07>

Infographic: <https://www.boem.gov/pr-19-ent-infographic>



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 (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>

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.

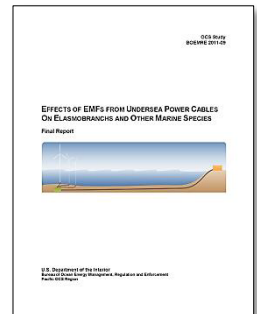
Database: <https://www.usgs.gov/centers/werc/science/pacific-coast-fisheries-gis-resource-database>



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.

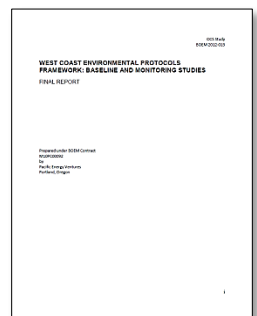
Report BOEMRE 2011-09: <https://espis.boem.gov/final%20reports/5115.pdf>



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

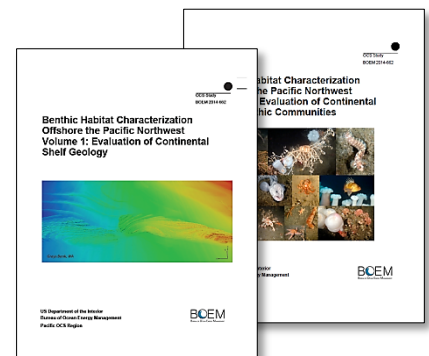
This study by Oregon State University provided baseline information about the seafloor environment and the types and distribution of benthic invertebrates in areas of potential renewable energy development on the Washington, Oregon, and northern California OCS. Knowledge of species-habitat relationships 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>

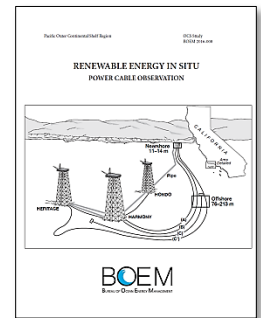


Completed (2016) — Renewable Energy *in situ* Power Cable Observation

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://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

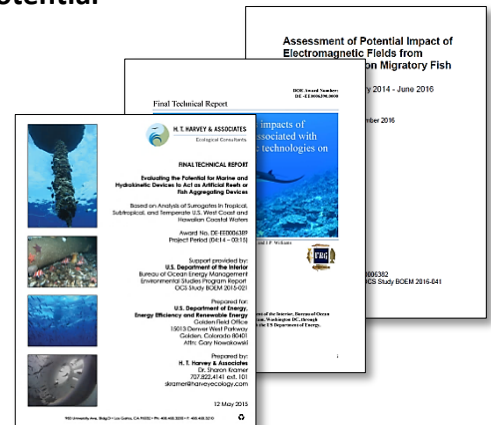
BOEM and the U.S. Department of Energy partnered on this study to identify and analyze data from ongoing projects and activities (surrogates) with stressors and receptors similar to those expected from marine renewable energy projects. Two reports examined potential impacts of electromagnetic fields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

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>



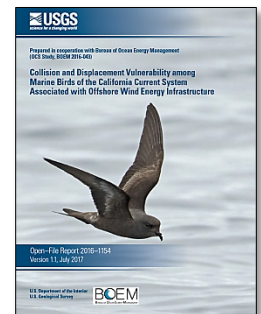
Completed (2016) — Developing and Applying a Vulnerability Index for Scaling the Possible Adverse Effects of Offshore Renewable Energy Projects on Seabirds on the Pacific OCS

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>

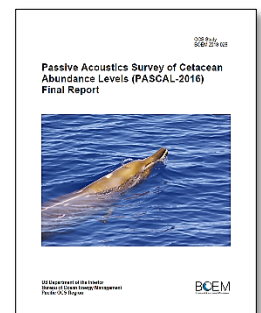
Webinar: <https://www.boem.gov/Science-Exchange-6>



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.

Report BOEM 2018-025: https://epis.boem.gov/final%20reports/BOEM_2018-025.pdf

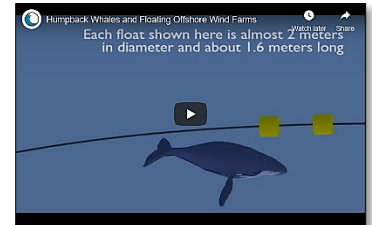
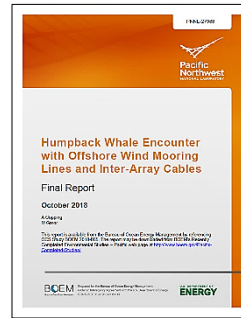


Completed (2018) — Humpback Whale Encounter with Offshore Wind Mooring Lines and Inter-Array Cables

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

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

Video Animation: <https://www.boem.gov/humpback-whales-floating-wind>



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

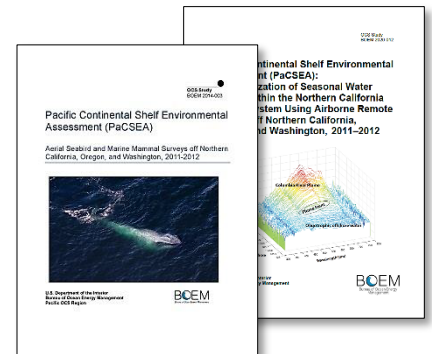
This study by the U.S. Geological Survey and U.S. Fish and Wildlife Service provided up-to-date information on the types, distribution, abundance, seasonal variation, and habitat use of marine mammals and seabirds along the northern California, Oregon, and Washington coasts. Aerial surveys using state-of-the-art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

Reports:

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

BOEM 2020-012: 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.

Reports:

BOEM 2020-008: https://epis.boem.gov/final%20reports/BOEM_2020-008.pdf

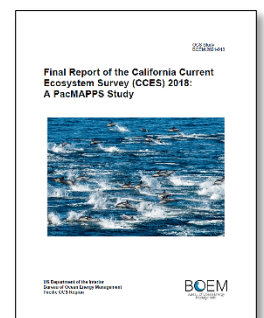
BOEM 2020-021: https://epis.boem.gov/final%20reports/BOEM_2020-021.pdf



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

This study was a partnership between BOEM, the National Oceanic and Atmospheric Administration's 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).

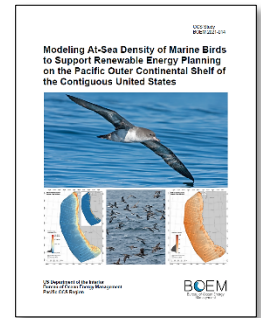
Report BOEM 2021-013: https://epis.boem.gov/final%20reports/BOEM_2021-013.pdf



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



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>

NEW Ongoing (2022–2025) — Ancient Landforms off the Washington Coast

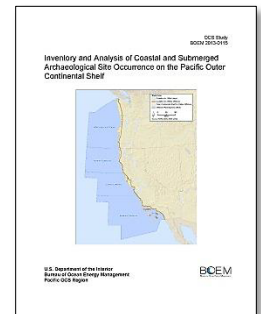
This study by Oregon State University will further refine modeling efforts and improve our understanding of submerged paleolandforms and ancient cultural landscapes offshore Washington. It will build on similar efforts in the BOEM Pacific Region to more fully understand inundation processes offshore the U.S. West Coast by synthesizing geological, geophysical, and environmental data and integrating those data with Native American Tribal oral histories and traditional knowledge. Information garnered from this study will inform the analysis of potential impacts to these significant cultural resources from offshore wind energy development and marine mineral extraction.

Study Profile: <https://www.boem.gov/pc-22-05>

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:

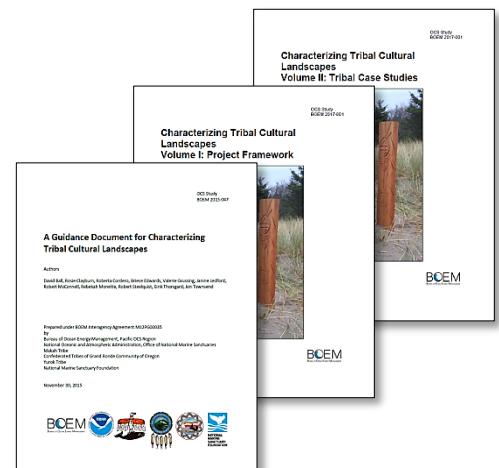
BOEM 2015-047 (Guidance Document): <https://www.boem.gov/2015-047>

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>

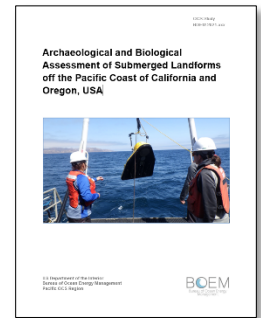
Webinar: <https://www.boem.gov/Science-Exchange-8>



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*

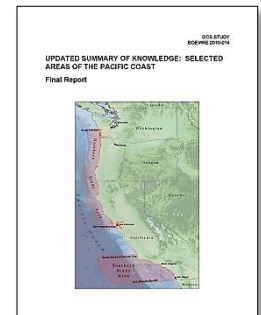


Information Synthesis Studies

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.

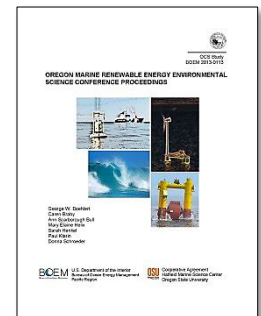
Report BOEMRE 2010-014: <https://espis.boem.gov/final%20reports/4955.pdf>



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.

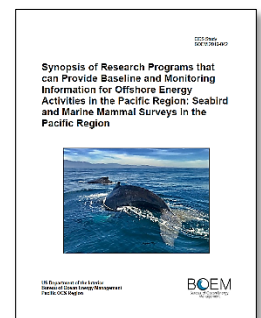
Report BOEM 2013-0113: <https://espis.boem.gov/final%20reports/5255.pdf>



Completed (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 (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

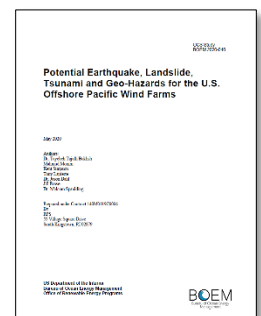


Completed (2020) — Potential Earthquake, Landslide, Tsunami and Geo-Hazards on the U.S. Offshore Pacific Wind Farms

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.

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>

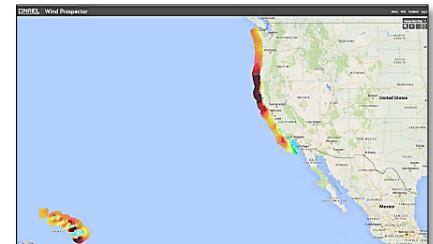


Resource, Technology & Infrastructure Studies

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 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.

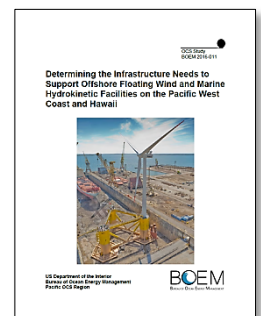
Data: <https://maps.nrel.gov/wind-prospector>



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>



Socioeconomic Studies

NEW **Ongoing (2022–2023) — Socioeconomic Characterization of West Coast Fisheries in Relation to Offshore Wind Development**

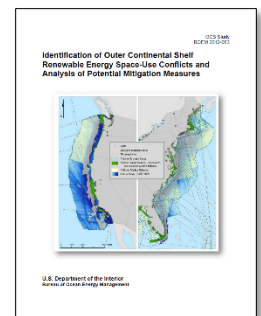
This study by the National Oceanic and Atmospheric Administration's National Marine Fisheries Service Northwest Fisheries Science Center is developing products that will help BOEM characterize West Coast fishing communities, including supportive industries (primary and secondary/ancillary markets), fishing-related 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://epis.boem.gov/final%20reports/5203.pdf>

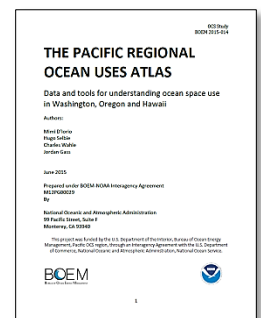


Completed (2015) — Pacific Regional Ocean Uses Atlas

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>



Other Studies Informing OCS Renewable Energy (not specific to Washington)

- 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
- 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>
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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/espis/#>

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

