ATLANTIC SCIENCE YEAR IN REVIEW 2020

BOEM Bureau of Ocean Energy Management

Overview

The Bureau of Ocean Energy Management (BOEM) funds environmental studies for information needed to predict, assess, and manage impacts from offshore energy and marine mineral activities on human, marine, and coastal environments as mandated under Section 20 of the Outer Continental Shelf Lands Act.

This year in review presents the studies completed in 2020 in support of BOEM's Offshore Renewable Energy Program along the Atlantic Coast. The studies represent a broad spectrum of research and monitoring to address a variety of environmental concerns and issues. Topics in this review include methods for tracking birds and fish, modeling pile driving, and paleolandforms and methodologies for identifying submerged cultural sites. This review represents a snapshot of the ongoing and completed studies funded in whole or in part by BOEM.

A special issue of *Oceanography*—"Understanding the Effects of Offshore Wind Development on Fisheries"—was published in December of 2020. The issue provides an overview of what has been learned from research and monitoring of offshore wind farm impacts on fisheries resources based on the European experience.

To learn more about other studies, please visit the BOEM website at www.boem.gov.

Images | (cover) releasing tagged piping plover, courtesy of Peter Paton | (top) *Endeavor* coring cruise | (middle) measuring the width of a crab | (bottom) stern section of City of Houston with potential rudder post remains

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Assessing Movements of Birds Using Digital VHF Transmitters: A Validation Study

Conducted by: University of Rhode Island and US Fish and Wildlife Service

Key researchers: P. Paton, C. Cooper-Mullin, S. Kouhi, P. Loring, J. Moore, J. Miller, G. Potty

Funded by: Bureau of Ocean Energy Management (BOEM)

Developing methodologies to measure interactions between birds and offshore wind turbines is a focal area for BOEM. This study evaluated automated radio telemetry technology and modeling methods to assess bird movements at Block Island Wind Farm (BIWF). One of the primary goals of this study was to conduct a series of calibration surveys to assess the detection probability of receiving stations with different configurations of antennas to track the offshore movements of digitally coded VHF (Very High Frequency) transmitters. Automated radio telemetry stations tracked movements of three focal species—common terns, roseate terns, and piping plovers—in the vicinity of BIWF from 2017–2019. Tracking stations on Block Island detected a total of 157 unique tags from 15 species, including the 3 focal species, 6 species of shorebirds, and 6 species of passerines. Of the three focal species tagged at breeding areas in coastal Rhode Island, Connecticut, and New York, 79% of the common terns, 24% of the roseate terns, and 33% of the piping plovers moving past Block Island were detected.

Findings

- Using digital VHF transmitters can provide useful information on macroscale offshore movements of birds.
- VHF tracking technology has difficulties tracking fine scale temporal and spatial movements of small birds such as passerines.

How BOEM will use this information

- Develop methodologies to track avian species in and around wind facilities after construction
- Identify mitigation measures to reduce interactions of birds with wind turbines

Additional information

Final report: https://espis.boem.gov/final%20reports/BOEM_2021-009.pdf

Images | (left) tagged plover | (center) drone testing near turbine at Block Island Wind Farm | (right) releasing a tagged plover
All photos courtesy of Peter Paton, URI

Tracking Movements of Migratory Shorebirds in the U.S. Atlantic Outer Continental Shelf Region

Conducted by: US Fish and Wildlife Service

Key researchers: P. Loring, A. Lenske, J. McLaren, M. Aikens, A. Anderson, Y. Aubry, E. Dalton, A. Dey, C. Friis, D. Hamilton, et al.

Funded by: Bureau of Ocean Energy Management (BOEM)

Numerous researchers across the continents are tagging birds for scientific research purposes. In this study, movement data was compiled from 3,955 individuals of 17 shorebird species tagged with digital VHF (very high frequency) transmitters at 21 sites across North and South America between 2014 and 2017. The movements of tagged shorebirds were tracked using a collaborative radio telemetry network, the Motus Wildlife Tracking System globe (http://motus-wts.org/). The study area encompassed a region of the US Atlantic Coast extending from Cape Cod, Massachusetts, to Back Bay, Virginia, and had extensive coverage of radio telemetry receiving stations. Movements and flight altitudes of 594 individuals of 12 shorebird species were identified to have sufficient detection data within the study area. The array of land-based automated radio telemetry stations was limited to assessing the flight paths and behavior of departing shorebirds within 20 km off the coast.

Findings

- Most model-estimated flight altitudes were estimated to occur above the Rotor Swept Zone (RSZ) of offshore wind turbines (25–250 m).
- Exposure to the RSZ was higher during fall relative to spring.
- Across all species, offshore flights during fall were associated with fair weather conditions.

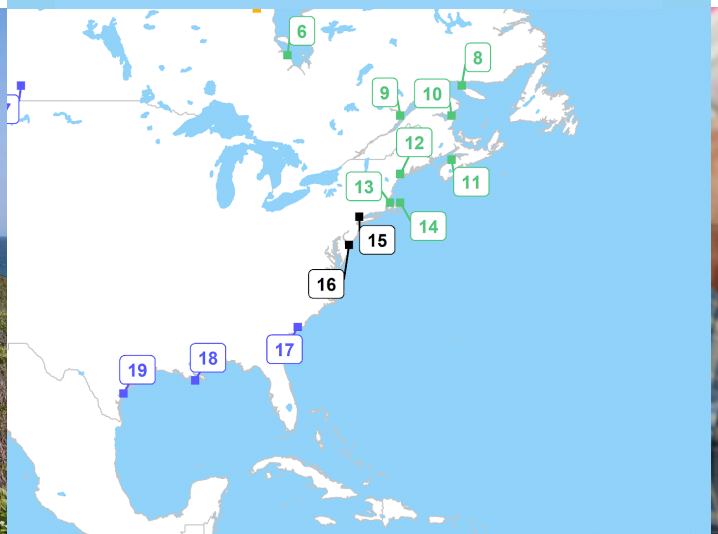
How BOEM will use this information

- Incorporate the findings in environmental assessments
- Design future tracking studies of birds

Additional information

Final report: https://www.boem.gov/sites/default/files/documents/renewable-energy/studies/Tracking-Migratory-Shorebirds-Atlantic-OCS.pdf

Images | (left) constructing tower | (center) locations of shorebird tagging sites | (right) digital VHF transmitter mounted on red knot, photo courtesy Kaiti Tithertington USFWS



Developing Protocols for Reconstructing Submerged Paleocultural Landscapes and Identifying Ancient Native American Archaeological Sites in Submerged Environment

Conducted by: University of Rhode Island

Key researchers: J. King, D. Robinson, C. Gibson, B. Caccioppoli

Funded by: Bureau of Ocean Energy Management (BOEM)

Considering the effects offshore energy development may have on submerged historic properties—including Native American cultural sites submerged by post-glacial sea level rise and now underwater on the continental shelf—is a significant concern for individual states, Tribes, other regulatory agencies, stakeholders, and researchers participating in environmental review and consultation for offshore development projects. The project was conducted in 2012 to 2019 by the University of Rhode Island Graduate School of Oceanography (URI-GSO), Rhode Island Coastal Resource Management Council, and Narragansett Indian Tribal Historic Preservation Office. The study involved the multidisciplinary investigation of five nearshore and offshore areas in Rhode Island waters. A series of workshops and field activities helped develop a clearly defined, standardized methodology to identify submerged areas of cultural significance to contemporary Tribal people. This project completed eight interrelated tasks and deliverables in collaboration with URI-GSO's project partners and with the input and assistance of multiple federally and state-recognized Tribes, Federal and state agencies, industry, and regional and international academic institutions.

Findings

- Identification of submerged land areas is challenging in the marine environment.
- Continued engagement with Tribes is critical to a successful process.

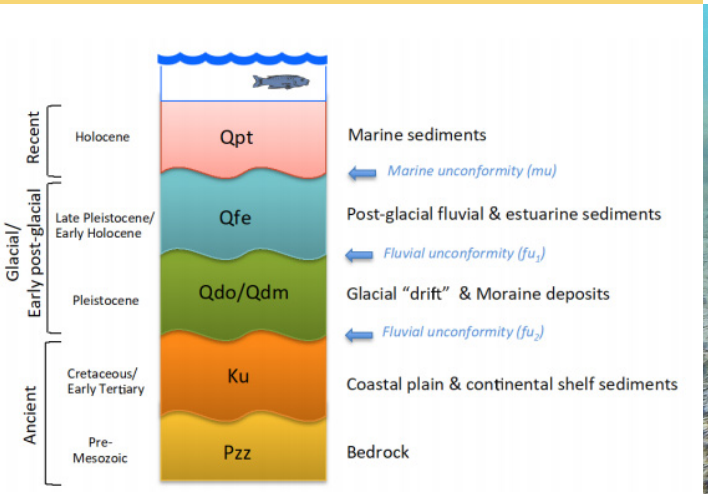
How BOEM will use this information

- Assist with the development of effective, culturally sensitive collaboration and consultation as part of the National Historic Preservation Act (NHPA) Section 106 compliance process

Additional information

- Summary report of the initial project workshop
- Field Report: 2013–2016
- Best Practices
- Geoarchaeological Modeling
- Final Report
- Project Video

Images | (left) researchers at Block Island, RI | (center) USGS stratigraphic framework ot the subsurface continental shelf off Rhode Island | (right) diver looking at submerged stump



North Carolina Collaborative Archaeological Survey: Wilmington East and West Wind Energy Areas

Conducted by: Bureau of Ocean Energy Management (BOEM) and National Oceanic and Atmospheric Administration (NOAA) Monitor National Marine Sanctuary

Key researchers: W. Hoffman, J. Hoyt, W. Sassorossi

Funded by: Bureau of Ocean Energy Management (BOEM)

Baseline archaeological data within wind energy areas is needed to minimize impacts to important archaeological sites on the Outer Continental Shelf. This study obtained baseline archaeological information in and around the Wilmington East and West Wind Energy Areas by ground truthing, via diver-based investigation, selected targets of archaeological potential. This project leveraged the results of reconnaissance-level geophysical survey conducted under BOEM studies in the region identifying potential archaeological targets warranting further investigation. Eight potential archaeological sites were investigated representing a broad range of cultural resources spanning from the late-nineteenth century through World War II, highlighting the diversity of potential resources likely present offshore North and South Carolina.

Findings

- Five of the eight targets investigated were confirmed to be archaeological sites, and the study recommended avoidance buffers and additional investigation for these sites.
- The remaining three targets were determined to not warrant further investigation.

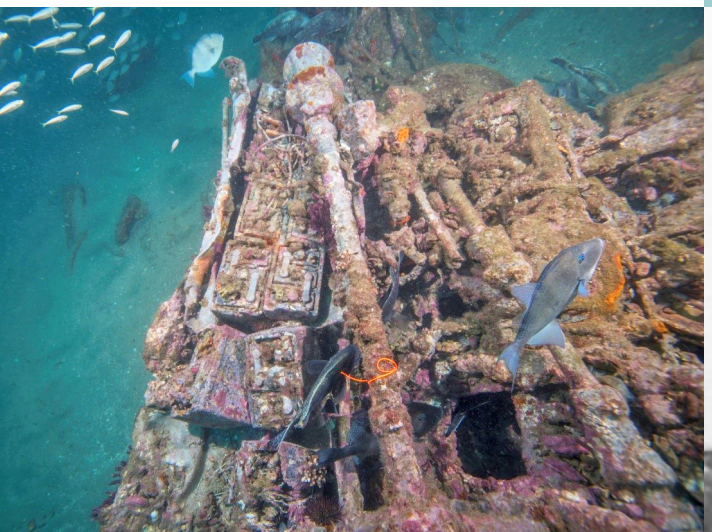
How BOEM will use this information

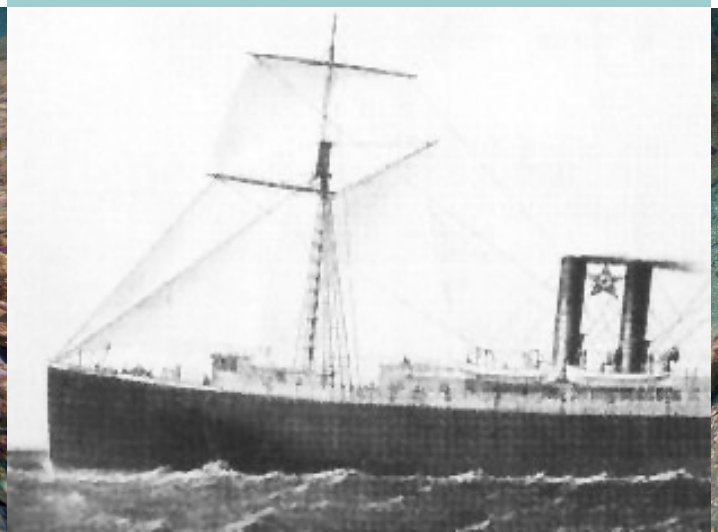
- Reduce the impact of wind energy development on archaeological sites by identifying their location and providing a zone for avoidance
- Assist BOEM in considering the effects of its activities on cultural resources under the National Historic Preservation Act and National Environmental Policy Act

Additional information

- Final report: https://espis.boem.gov/final%20reports/BOEM_2020-016.pdf

Images | (left) batteries located on port side of site of 6537K_1 | (center) City of Houston (Wrecksite 2007) | (right) copper Cookware exposed at site of 6537K_1





A Parametric Analysis and Sensitivity Study of the Acoustic Propagation for Renewable Energy

Conducted by: CSA Ocean Sciences Inc.

Key researchers: K. Heaney, M. Ainslie, M. Halvorsen, K. Seger, R. Müller, M. Nijhof, T. Lippert

Funded by: Bureau of Ocean Energy Management (BOEM)

Sound generated during pile driving may be a significant source of potential impacts to marine life from offshore wind development. This study examined the parameters that affect the results of sound modeling for monopile wind turbines. The key parameters include water depth, sediment type, and water column temperature. The contractor developed a new model for pile driving noise and calibrated the model using measurements from pile driving events in Europe. The product is a spreadsheet that generate the sound exposure for fish, sea turtles, and marine mammals by entering simple parameters such as water depth and monopile diameter. The modeled sound exposure is then compared to National Marine Fisheries Service prescribed levels for injury and harassment.

Findings

- Additional modeling is need, if a pile site differs by more than 50% in depth, consists of more than 1 **ϕ** in grain size, is installed during different seasons, or occurs at intervals of 15 km farther away or closer to shore.
- New models should be generated during the month of proposed activity to understand how sound may travel through the environment.

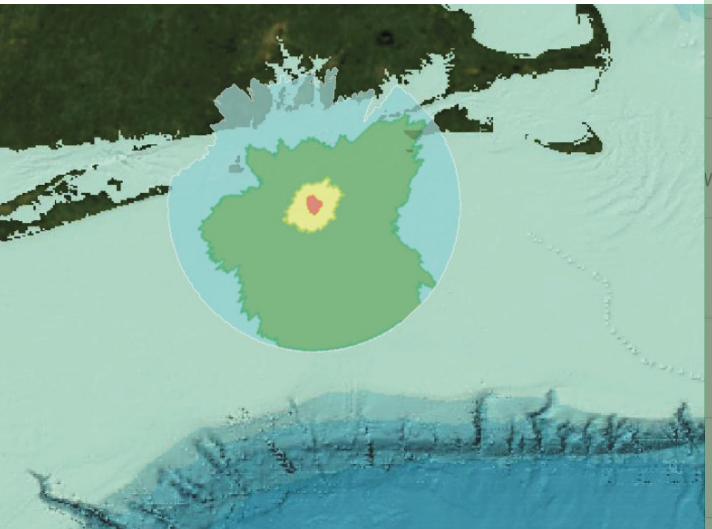
How BOEM will use this information

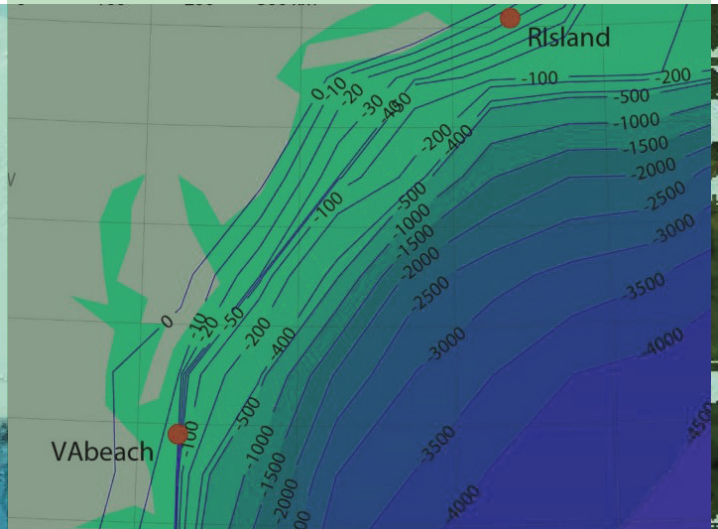
- Evaluate the impacts from pile driving
- Inform review of modeling results provided by offshore wind developers

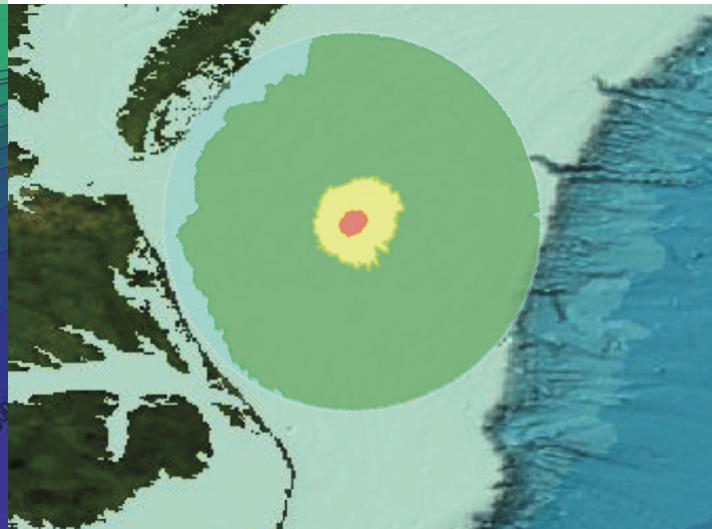
Additional information

- Final report: https://espis.boem.gov/final%20reports/BOEM_2020-011.pdf

Images | (left) plan view of sound field off Rhode Island | (center) map of Rhode Island and Virginia Beach sites | (right) plan view of sound fields off the coast of Virginia







Radar Interference Analysis for Renewable Energy Facilities on the Atlantic Outer Continental Shelf

Conducted by: Booz Allen Hamilton

Key researchers: R. Colburn, C. Randolph, C. Drummond, M. Miles, F. Brody, C. McGillen, A. Krieger, R. Jankowski

Funded by: Bureau of Ocean Energy Management (BOEM)

The presence of wind energy installations is known to impact land-based radar systems as wind turbines consist of large metal structures that can generate a return signal to radars. Radar signals generated by objects other than the intended targets (e.g., the ground, artificial structures, wind turbines) are referred to as "clutter" or "interference," and represent a potential impact to be investigated under the National Environmental Policy Act. This study investigates land-based radar interference impacts on nine total wind farms, seven of which were in planning stages, and two of which were based on hypothetical future scenarios. The radar type with the most radars affected was the SeaSonde, reflecting the large number of SeaSondes along the Atlantic Coast. The research team also qualitatively ranked the severity of impacts caused by each wind farm. Skipjack, South Fork, and Grand Strand were found to have low radar impacts. Mayflower, Vineyard Wind, Bay State Wind, and Ocean Wind were found to have moderate impacts, and Empire Wind was found to have higher impacts.

Findings

- Wind farms are within line of site of 36 radar systems, indicating that they will generate interference to these radars under normal atmospheric conditions.
- Mitigation may be possible through software upgrades.

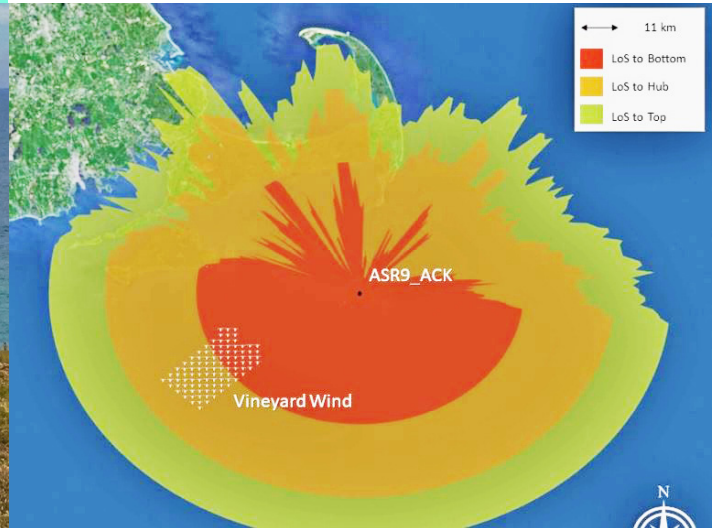
How BOEM will use this information

- Evaluate the impacts of wind turbines on radar systems
- Develop mitigation measures for the interference

Additional information

- Final report: https://www.boem.gov/sites/default/files/documents/environment/Radar-Interferance-Atlantic-Offshore-Wind_0.pdf

Images | (left) proposed and hypothetical wind farm locations | (center) SeaSonde® high frequency radar system in view of wind turbines | (right) line of sight modelling



Movement and Habitat Selection by Migratory Fishes Within the Maryland Wind Energy Area and Adjacent Reference Sites

Conducted by: University of Maryland Center for Environmental Science

Key researchers: D. Secor, M. O'Brien, E. Rothermel, C. Wiernicki, H. Bailey

Funded by: Bureau of Ocean Energy Management (BOEM)

Seasonal transit and habitat occurrence of striped bass and Atlantic sturgeon in offshore wind energy areas are important baseline information needed to assess potential impacts to these species from offshore wind energy development. Biotelemetry was used in a before after-gradient design centered in the Maryland Wind Energy Area to measure seasonal patterns of migration by Atlantic sturgeon and striped bass. Models were used to relate these patterns to gradients of depth, temperature, and other oceanographic variables. Acoustically tagged striped bass and Atlantic sturgeon were monitored with an extensive telemetry receiver array. From November 2016–December 2018, the array logged 745,385 detections of 1,286 acoustically tagged fish, most of which were target species of the study: striped bass (315 individuals) and Atlantic sturgeon (352 individuals). An additional 18 species were identified, including Atlantic cod; Atlantic bluefin tuna; black sea bass; blacktip, bull, dusky, sand tiger, tiger, and white sharks; and cownose ray.

Images | (left & right) Maryland research team in the field | (center) Atlantic sturgeon hot spots in Maryland wind energy area

Findings

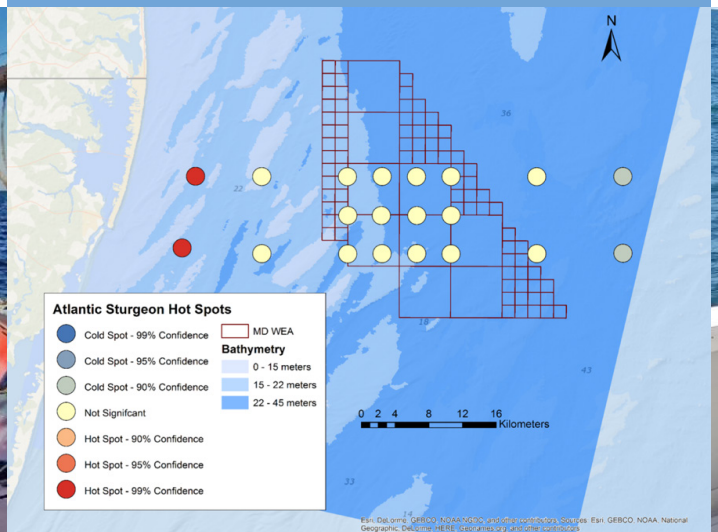
- Detections of Atlantic sturgeon occurred in autumn, early winter, spring, and early summer.
- Striped bass occurrence was more concentrated during winter months, with a rapid pulse in spring.
- Both species moved through the study area in an average of 1.6 and 2.5 days for Atlantic sturgeon and striped bass, respectively.
- Single-variable analyses and habitat models alike identified depth and temperature as key variables; Atlantic sturgeon tended to occur at shallower sites and warmer temperatures while striped bass were more likely at great depths and cooler conditions.

How BOEM will use this information

- Design future post-construction telemetry studies of fish
- Provide baseline information for environmental assessments of future offshore wind development

Additional information

- Final report: https://espis.boem.gov/final%20reports/BOEM_2020-030.pdf



Occurrence of Commercially Important and Endangered Fishes in Delaware Wind Energy Areas Using Acoustic Telemetry

Conducted by: University of Delaware and Delaware State University

Key researchers: D. Haulsee, M.J. Oliver, D. Fox

Funded by: Bureau of Ocean Energy Management (BOEM)

Prior to offshore wind development, baseline information is needed on endangered species such as the Atlantic sturgeon. Between 2017–2019, an extensive acoustic telemetry project monitored the timing and location of Atlantic sturgeon, winter skate, and other acoustically telemetered species in the Delaware Wind Energy Area. This study was conducted to better understand the potential of encountering these species during future development in the area, as well as address potential impacts to commercial fisheries (e.g., winter skate). Environmentally driven models of Atlantic sturgeon and winter skate were developed. Between Feb 2017 and Feb 2019, receivers recorded 43,620 detections of 360 individual Atlantic sturgeon. Acoustic detections from all receivers in the array documented the presence of 26 different marine fish and mammals, which creates a baseline to inform future monitoring efforts.

Findings

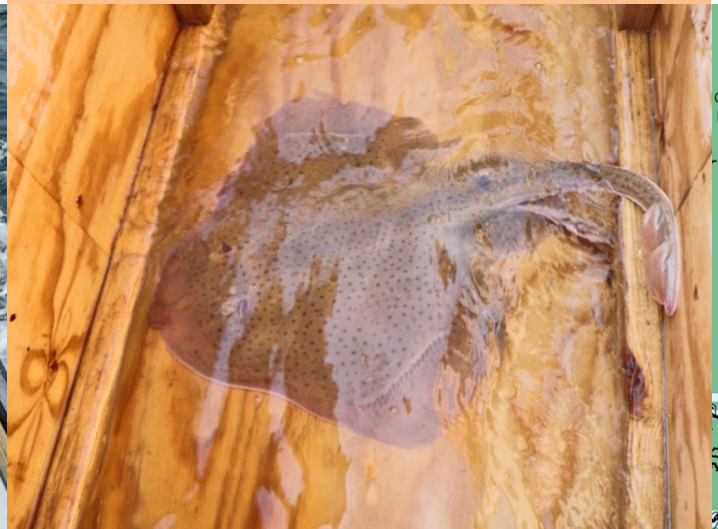
- Atlantic sturgeon were observed during all months of the period but occurred most frequently in the late fall/early winter.
- Atlantic sturgeon were also most concentrated in the northern portion of the study region, except in the late fall/early winter, when they were detected throughout the entire array.
- Winter skate occurred less commonly and were concentrated in the shallowest portion of the study region.
- Both species appear to be related to bottom type and topography, which is most distinctive in the northern portion of the Delaware Wind Energy Area.

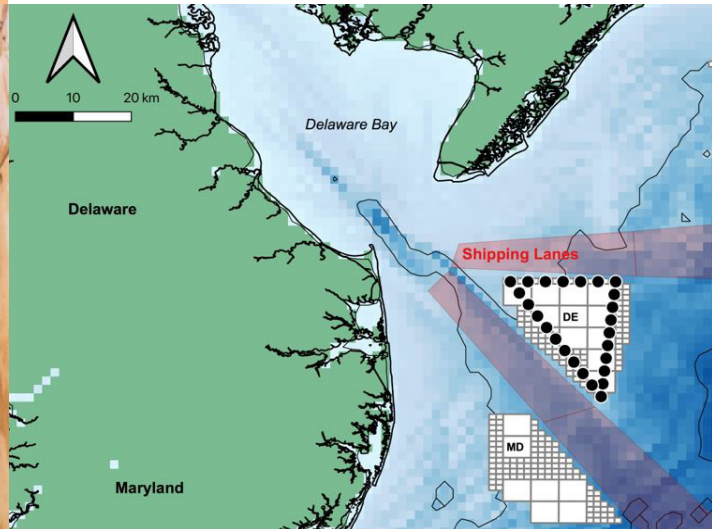
How BOEM will use this information

- Baseline information for environmental assessments of offshore wind development
- Improve future post-construction telemetry studies of fish

Additional information

- Final report: https://espis.boem.gov/final%20reports/BOEM_2020-020.pdf





Images | (left) collecting metadata for Atlantic sturgeon | (center) map of study area and telemetry stations | (right) collecting metadata for Winter skate

Spatial and Temporal Distributions of Lobsters and Crabs in the Rhode Island/ Massachusetts Wind Energy Area

Conducted by: University of Rhode Island

Key researchers: J. Collie, A.M. Mercer, C. Glass, M. Long, J. Langan

Funded by: Bureau of Ocean Energy Management (BOEM)

The Southern New England Cooperative Ventless Trap Survey (SNECVTS) was developed to provide a baseline assessment of the lobster and crab populations in the Rhode Island/Massachusetts Wind Energy Area prior to offshore wind energy development in southern New England. This study reports on a one-year continuation of SNECVTS, which was originally conducted in 2014–2015. The survey was designed to contribute to the assessment of the Southern New England lobster stock, which is currently at a low level of abundance. To the extent possible, this project followed Atlantic Marine States Fisheries Commission survey protocols and adhered to the Atlantic Coastal Cooperative Statistics Program data requirements. Over the course of three years, a total of 11,990 trap hauls were sampled.

Findings

- The study sampled 26,449 lobsters and 95,859 Jonah crabs.
- Seasonally, lobster abundance was highest in summer, and Jonah crab abundance was highest in summer and fall.
- Spatially, lobster abundance was highest in the eastern lease blocks characterized by boulders and the transition from boulders to sand.
- Jonah crab abundance was highest in the northern and central lease blocks, which are characterized by soft sediments and sand.

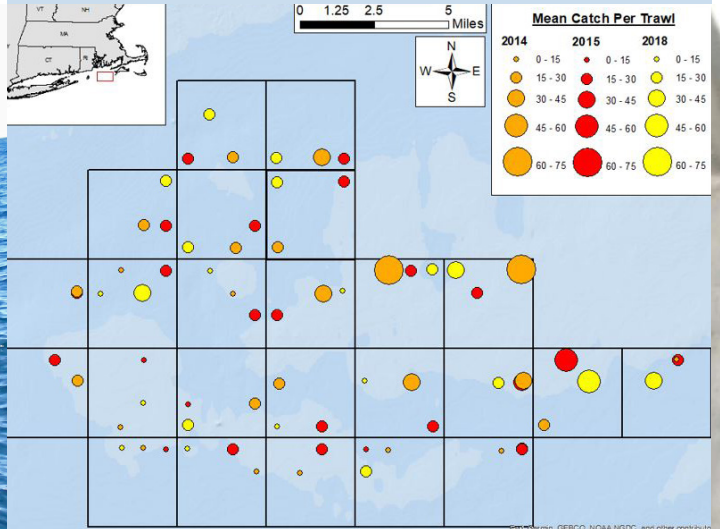
How BOEM will use this information

- Establish a baseline to assess the potential effects of offshore wind energy development
- Inform future designs for post-construction monitoring

Additional information

- Final report: https://espis.boem.gov/final%20reports/BOEM_2021-010.pdf

Images | (left) sampling gear | (center) lobster abundance by year and sampled aliquot | (right) tagged lobster



RODEO: Realtime Opportunity for Development Environmental Observations

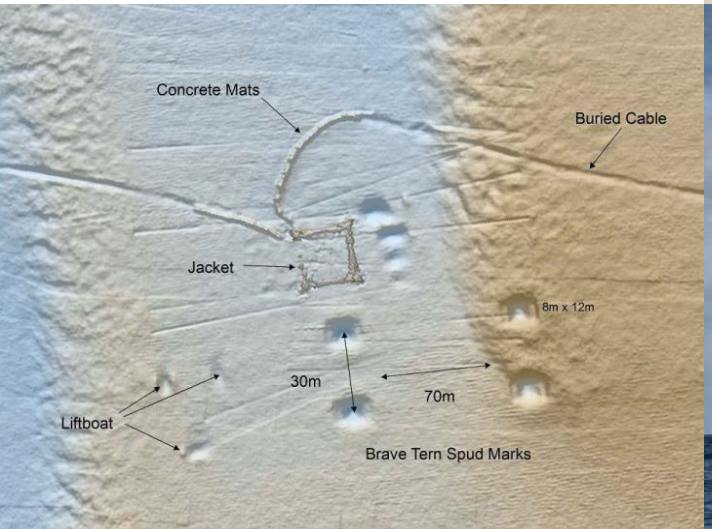
The purpose of the study Realtime Opportunity for Development Environmental Observations is to make direct, real-time measurements of the nature, intensity, and duration of potential stressors during the construction and initial operations of selected proposed offshore wind facilities. The purpose also includes recording direct observations during the testing of different types of equipment that may be used during future offshore development to measure or monitor activities and their impact producing factors.

Data collected under RODEO may be used as input to analyses or models that are used to evaluate effects from future offshore activities. This study is not intended to duplicate or substitute for any monitoring that may otherwise be required to be conducted by the developers of the proposed projects. Also, RODEO monitoring is coordinated with the industry and is not intended to interfere with or result in delay of industry activities.

The Block Island Wind Farm (BIWF) is the first facility to be monitored under the RODEO study. Observations were made during the installation of the wind turbine foundations, the installation of the turbines, and early operations. The following pages present results from two studies that monitored the seafloor recovery after disturbance from construction activities and alterations in benthic macrofaunal community characteristics caused by the presence of structures at the BIWF.

You can find all of the RODEO reports on a dedicated website: www.boem.gov/rodeo

Images | (left) seafloor disturbance features | (right) Block Island Wind Farm

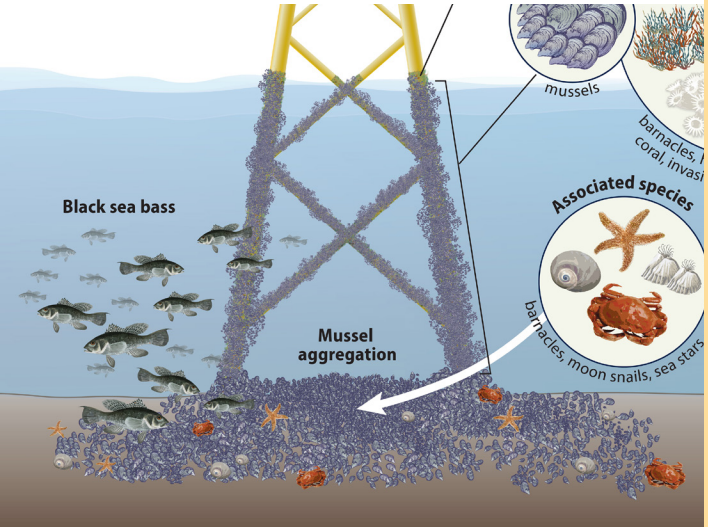


Benthic Monitoring During Wind Turbine Installation and Operation at the Block Island Wind Farm, Rhode Island

Conducted by: HDR

Key researchers: Z. Hutchison, M. LaFrance Bartley, P. English, J. King, S. Grace, B. Kresning, C. Baxter, K. Ampela, M. Deakos, A. Khan

Funded by: Bureau of Ocean Energy Management (BOEM)



Benthic and epifouling monitoring was conducted within the Block Island Wind Farm (BIWF) project area over four years (2016 to 2019) after turbine installation. Seafloor samples were collected at Turbines 1, 3, and 5 using a grab sampler deployed from a ship and analyzed for marine life, sediment type, and carbon content. Divers collected samples within the foundation structure during the last two years. Video transects of the legs were also conducted by divers. Additionally, a floating camera observed the seafloor near the platform legs.

Findings

- Submerged sections of the BIWF jacket foundation structures were completely encrusted by mussels (*Mytilus edulis*) and associated species.
- Significant modification of the seabed occurred within the footprint of the turbine foundations, with the area underneath Turbine 1 exhibiting the fastest rate of change.
- An increase in abundance of black sea bass (*Centropristis striata*) around the foundations was observed between Years 2 and 3.
- Benthic habitat four years after installation remain localized, with a profound change from a sandy habitat to a habitat characterized by mussel aggregations with associated organic matter, sediment fines, and macrofaunal communities.

Images | (left) species at the structure foundations at Block Island Wind Farm | (right) benthic sampling at Block Island Wind Farm

How BOEM will use this information

- To understand of changes to macrofaunal and sediment characteristics resulting from wind facility construction and initial operations in the New England region over short time scales
- To extrapolation to larger wind facilities and provide useful information on the effects of jacket type foundations, which are generally underrepresented in European studies

Additional information

- Final report: https://espis.boem.gov/final%20reports/BOEM_2020-044.pdf

Seafloor Disturbance and Recovery Monitoring at the Block Island Wind Farm, Rhode Island

Conducted by: HDR

Key researchers: A. Khan, K. Smith

Funded by: Bureau of Ocean Energy Management (BOEM)

Seafloor disturbance and recovery monitoring was conducted in and around the Block Island Wind Farm (BIWF) to assess the impact of wind farm construction activities on the seafloor. Previous studies from Europe have shown that introduction of solid structures onto the seafloor, such as the four-legged BIWF turbine jacket foundations, can modify near-bottom current flow processes and induce scour. Five rounds of seafloor bathymetry surveys were conducted within a defined construction work area from a small research vessel using a Reson SeaBat 7125 ultra-high resolution multibeam echosounder. Seafloor bathymetry data from the first and second surveys were used primarily to characterize the different types of seafloor disturbance features that resulted from construction activities. Data from the three rounds of post-construction surveys were used to evaluate the rate of seafloor recovery.

Findings

- A relatively small area of the seafloor off Block Island was disturbed by wind farm construction activities.
- Much of the disturbed area fully recovered within a relatively short time (1–2 years), after which no clear sign of any disturbance was evident as indicated by interpretation of the survey data.

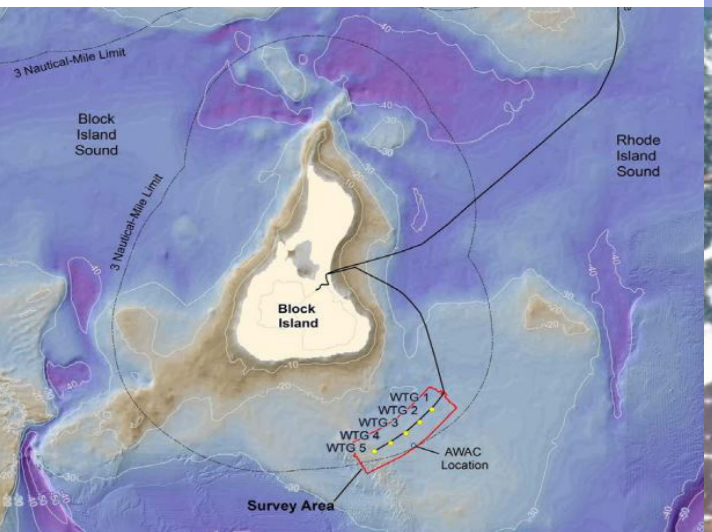
How BOEM will use this information

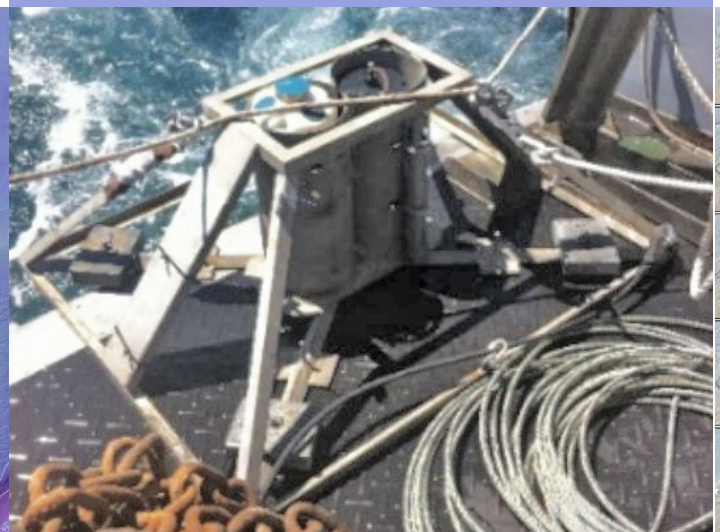
- Improve the evaluation of the duration of seafloor impacts from offshore wind foundation installation
- To extrapolate to larger wind facilities and provide useful information on the effects of jacket type foundations which are generally underrepresented in European studies

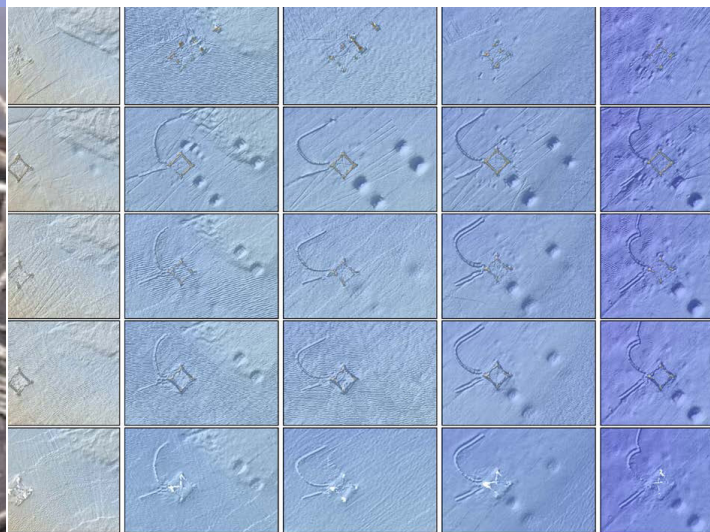
Additional information

- Final report: https://espis.boem.gov/final%20reports/BOEM_2020-019.pdf

Images | (left) study area | (center) seafloor frame | (right) time series of seafloor disturbance at Block Island Wind Farm







What's Next

Here are a few of the new and continuing studies that are underway:

Pile driving of monopile foundations during the installation of offshore wind turbines creates significant **noise** in the environment. The sound can be **reduced by the use of bubble curtains**. During the installation of the two turbines off the coast of Virginia, a bubble curtain was used for the installation of one foundation and not used for the other. The sound was measured during both events allowing for a comparison of the noise generated.
Expected completion: 2021

Working with NOAA, BOEM is funding broad scale **surveys for the presence of marine mammals and sea turtles**. This work also includes the use of **passive acoustic monitoring** to listen for whale calls. Researchers tagged loggerhead sea turtles and tracked their movements. All these efforts are part of the second five-year study called Atlantic Marine Assessment Program of Protected Species (AMAPPS).
Expected completion: 2021

Teaming with NOAA and Woods Hole Oceanographic Institution, BOEM is funding a study to examine the **response to impulsive sounds** like pile driving. Using sound recordings representing pile driving, **black sea bass and longfin squid** were exposed within a large tank. The behavioral responses were observed before, during and after exposure to the sound. Squid exhibited a startle response to the sound.
Expected completion: 2021