OCS Study
BOEM 2017-014

Effects Matrix for Evaluating Potential Impacts of Offshore Wind Energy Development on U.S. Atlantic Coastal Habitats

U.S. Department of the Interior
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ABOUT THE COVER

Cover photo (Block Island Wind Facility, Rhode Island) courtesy of Whitney Fiore. Used with permission.

Contents

Figures

Tables

Acronyms

AC	alternating current
BOEM	Bureau of Ocean Energy Management
BSEE	Bureau of Safety and Environmental Enforcement
CFR	Code of Federal Regulations
COP	Construction and Operations Plan
DC	direct current
DOI	U.S. Department of the Interior
DP2	dynamically positioned
EA	Environmental Assessment
EIS	Environmental Impact Statement
EMF	electromagnetic field
ER	Environmental Report
ESI	Environmental Sensitivity Index
FONSI	Finding of No Significant Impact
FPEIS	Final Programmatic Environmental Impact Statement for Alternative Energy Development and Production and Alternate Use of Facilities on the Outer Continental Shelf
HDD	horizontal directional drilling
ICD	intensity, context, and duration
MMS	Minerals Management Service
MW	megawatt
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
OCS	Outer Continental Shelf
OSW	offshore wind
PEIS	Programmatic Environmental Impact Statement
psu	practical salinity unit
RAP	Research Activities Plan
ROD	Record of Decision
ROV	remotely operated vehicle

SAP	Site Assessment Plan
SAV	submerged aquatic vegetation
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VOWTAP	Virginia Offshore Wind Technology Advancement Project
WEA	Wind Energy Area
WTG	wind turbine generator

Executive Summary

This white paper provides a means of evaluating potential impacts of offshore wind (OSW) facilities on coastal habitats along the U.S. Atlantic coast in support of National Environmental Policy Act (NEPA) documentation for OSW facilities. The intent of this white paper is to provide a mechanism to assist in efforts supporting a more "efficient and coordinated permitting process for offshore wind energy developments." To this end, the final product is an effects matrix that generates a table of overall effects using intensity, context, and duration, as well as ranking (thresholds) for impacts. The impact levels used (negligible, minor, moderate, and major) for each combination of Construction and Operations Plan (COP) actions and coastal habitat follow the definitions for negligible, minor, moderate, and major in the *Final Programmatic Environmental Impact Statement for Alternative Energy Development and Production and Alternate Use of Facilities on the Outer Continental Shelf* (MMS 2007a), referred to hereafter as the MMS FPEIS.

More than 200 documents (exclusive of geospatial data sources) from agencies, industry, and scientific publications were reviewed for information relevant to the potential (adverse) impacts of OSW facility construction, operation, maintenance, and decommissioning on coastal habitats (e.g., reefs, tidal flats, submerged aquatic vegetation, beaches, dunes, marshes, and maritime forests).

While habitat loss has been identified as an issue in the literature reviewed as part of this white paper, most of the focus is on offshore and marine species habitat loss and effects. A review of the few Bureau of Ocean Energy Management (BOEM) documents prepared to date for OSW facilities indicated potential impacts of COP activities on coastal habitats were considered negligible to minor in most cases as a result of landfall occurring in already developed locations or existing rights-of-way. The use of existing rights-of-way is likely in future OSW projects to the extent feasible. The extremely small footprint of areas of potential impacts on coastal habitats, when compared with the large marine footprint of the offshore wind turbine generator components, may also influence the evaluation of impacts. Potential impacts on onshore resources were addressed briefly for terrestrial birds and mammals with respect to substation construction and overhead transmission lines in several instances in literature reviewed.

More recent documents and/or publications that address coastal habitat impacts suggest that coastal and onshore portions of the route present the greatest environmental and permitting challenges, making this white paper, and others, timely. Almost all documents recommend avoiding sensitive areas and acquiring more data for evaluating potential impacts of OSW facilities on environmental resources to inform decision-making, especially with respect to baseline data. Most studies conducted thus far related to biological resources including habitats affected by offshore installation and operation of OSW facilities (or preliminary investigations conducted as part of site assessment and site characterization activities) have focused on avian species, marine mammals, and other marine species (e.g., benthic organisms and fish). Data on effects on coastal habitats from COP activities are needed with respect to landfall of cable transmission lines, and effects of increased wave disturbance on coastal habitats. Publicly available geospatial data for mapping coastal, intertidal, and nearshore marine habitats were compiled for the U.S. Atlantic coast as a means of reference for determining coastal habitats that would be affected by OSW facilities. Over 50 data layer sources were compiled to provide a set of baseline geospatial data resources that map the affected environment along the U.S. Atlantic coast. Large-scale national and regional efforts were essential to this effort, and included datasets published by the National Oceanic and Atmospheric

Administration, U.S. Fish and Wildlife Service, U.S. Geological Survey, U.S. Environmental Protection Agency, and The Nature Conservancy. Datasets included Environmental Sensitivity Index (ESI) atlases, National Wetlands Inventory, National Gap Analysis Program Land Cover Data - Version 2, Ecoregion coverages, and data products from the Northwest Atlantic Marine Assessment. The ESI atlases, in particular, were a valuable data resource from New Hampshire to Georgia, given recent updates since 2014.

An effects matrix was developed based on an analysis of effects of COP actions and effects on each habitat. The purpose of the COP is to provide a description of all proposed activities and facilities that are planned for construction and use for a proposed project under a commercial lease. Pursuant to 30 Code of Federal Regulations (CFR) 585. 620–585.626, the COP must include a description of all planned facilities, including onshore and support facilities, as well as anticipated project easement needs for the project. It must also describe the activities related to the project including construction, commercial operations, maintenance, decommissioning, and site clearance procedures. A COP is prepared to demonstrate that the project is being conducted in a manner that conforms to responsible offshore development per 30 CFR 585.621, inclusive of the application of best management practices.

Effects of each potential COP action were evaluated with respect to intensity and context,[1] as well as duration, per NEPA regulations and consistent with thresholds identified in the MMS FPEIS (MMS 2007a), using rankings of negligible impact (0), minor adverse impact (1), moderate adverse impact (2), and major adverse impact (3). These ranks were compiled and a matrix was generated that presents both an overall range of impacts for each potential COP action/coastal habitat combination (such as a cable landfall on a beach/dune habitats) as well as the individual ranks for intensity, context, and duration used to generate the overall range. The effects matrix is intended to provide the user (whether it be BOEM, a wind developer, or a contractor) with: (1) a screening tool that can be used to ascertain the extent of effects that may occur for various COP activities over the spectrum of coastal habitat types; (2) information to consider as part of BOEM's review of developer-submitted COPs to identify potential effects, including those that may be significant, and help facilitate identification of avoidance and minimization of such effects; (3) an updatable record of data and scientific literature related to coastal habitats, COP, and other effects; and (4) identification of effects determinations that have been made for similar COP activities in BOEM decision documents (Findings of No Significant Impact [FONSI] or Records of Decision [ROD]) so that the determinations may be quickly identified, summarized, and incorporated by reference. The effects matrix is provided as an Excel spreadsheet that can be updated as additional information becomes available with respect to data or scientific literature, potential impacts of OSW facilities on coastal habitats, and BOEM effects determinations in future NEPA decision documents.

[1] Depending on the resource, context looks at society as a whole (human, national), the affected region, and the affected interests, and locality and intensity refer to the severity of impact (40 CFR §§ 1500–1508).

Chapter 1
Introduction

The U.S. Department of the Interior (DOI) awarded 11 commercial leases for offshore wind (OSW) facility development by the end of 2015 with an estimated capacity of 14.6 gigawatts (DOE and DOI 2016). In December of 2016, the Bureau of Ocean Energy Management (BOEM) held a sale for a lease area offshore New York and a lease sale for the Kitty Hawk Wind Energy Area (WEA) offshore North Carolina is scheduled for March 2017. In addition, as of February 2017, a potential wind lease area is being considered by BOEM in the state of South Carolina.[2] The only existing OSW facility on the offshore of the Atlantic Coast is the Block Island OSW facility (Rhode Island), which is located entirely within state waters. BOEM has jurisdiction only for the transmission cable portion of the Block Island facility, which occurs within federal waters.

Nearly 80% of U.S. electricity demand is in coastal states and clean, renewable, OSW energy has the potential to reduce greenhouse gas emission and meet twice the total energy demand in the U.S. (DOE and DOI 2016). Development of OSW energy in the U.S. requires that key issues, including technology and cost, effective stewardship of natural resources, and an understanding of both benefits and costs of this renewable energy source, be addressed (DOE and DOI 2016).

This white paper provides a means of evaluating potential impacts of OSW energy development on coastal habitats (see Chapter 3 for definitions and descriptions of costal habitats) along the U.S. Atlantic coast in support of National Environmental Policy Act (NEPA) documentation for OSW facilities. The intent of this white paper is to assist in efforts supporting a more efficient and coordinated permitting process for OSW with respect to the NEPA analysis and process. To accomplish this, available literature was compiled and reviewed for information relevant to the affected environment and effects on coastal habitats. For the purposes of this paper, coastal habitats examined are based on a combination of habitats mapped for Environmental Sensitivity Index (ESI) developed for the Hazardous Materials Response Division of the Office of Response and Restoration under the National Oceanic and Atmospheric Administration (NOAA), which include shoreline habitats and sensitive biological resources (as well as human-use resources), estuarine habitats of the National Wetlands Inventory, and other coastal resource data, as presented in this document. The final product is an effects matrix that generates a table of overall effects using intensity, context, and duration, as well as ranks (thresholds) of impacts (negligible, minor, moderate, and major) for each combination of Construction and Operations Plan (COP) action and coastal habitat.

1.1 BOEM Offshore Wind Authority and Regulatory Process

The Energy Policy Act of 2005, Public Law 109-58, added Section 8(p)(1)(C) to the Outer Continental Shelf Lands Act, which authorized the Secretary of the Interior to issue leases, easements, or rights-of-way on the Outer Continental Shelf (OCS) for the purpose of wind energy

[2] A Call for Nominations and Notice of Intent to prepare an Environmental Assessment was issued on November 23, 2015 (80 FR 73817).

development (43 U.S. Code 1337(p)(1)(C)). The Secretary of the Interior delegated this authority to the former Minerals Management Service (MMS), now BOEM. Final regulations implementing this authority at Title 30 of the Code of Federal Regulations (CFR) Part 585 were promulgated on April 22, 2009.

In 2010, the creation of BOEM and the Bureau of Safety and Environmental Enforcement (BSEE) focused on dividing regulatory responsibility for the offshore mineral development program and left regulatory responsibility for renewable energy entirely with BOEM. However, the Secretarial Order that created the two bureaus always envisioned that there would be a future division of administrative responsibility for renewable energy.

This division of responsibility for renewable energy would have BOEM continue to oversee the identification and leasing of offshore areas for renewable energy development and evaluation of proposed development plans, while BSEE's mission is to enforce safety, environmental, and conservation compliance with any associated legal and regulatory requirements during project construction and future operations. The bureaus are working together to implement these changes.

BOEM's renewable energy program has four distinct phases: planning, leasing, site assessment, and construction and operations, and engages key stakeholders throughout the process. The decision making process is outlined below.

- Planning and Analysis. The first phase is to identify suitable areas to be considered for wind energy leasing through collaborative, consultative, and analytical processes, including input from state Renewable Energy Task Forces, public information meetings, and other stakeholders.
- Lease Issuance. The second phase, issuance of a commercial wind energy lease, gives the lessee the exclusive right to subsequently seek BOEM approval for the development of the leasehold. The lease does not grant the lessee the right to construct any facilities; rather, the lease grants the lessee the right to use the leased area to develop its plans, which must be approved by BOEM before the lessee can move on to the next stage of the process (see 30 CFR 585.600 and 585.601).
- Approval of a Site Assessment Plan (SAP). The third stage of the process is the submission of a SAP, which contains the lessee's detailed proposal for the construction of a meteorological tower, installation of meteorological buoys, or a combination of the two on the leasehold. BOEM's approval of a SAP allows the lessee to install and operate site assessment facilities. The lessee's SAP must be approved by BOEM before it conducts these site assessment activities on the leasehold. BOEM may approve, approve with modification, or disapprove a lessee's SAP (see 30 CFR 585.605–585.618). Once BOEM approves the SAP, the applicant has 5 years to complete site characterization and site assessment activities.
- Approval of a COP. The fourth stage of the process is the submission of a COP. The lessee submits the COP (a detailed plan for the construction and operation of a wind energy project on the lease) 6 months prior to the end of the 5-year site assessment term. After preparation of a site- and project-specific NEPA document. BOEM may approve, approve with modification, or disapprove a lessee's COP (see 30 CFR 585.620–585.638). BOEM's approval of a COP allows the lessee to construct and operate wind turbine generators and associated facilities for a term of 25 years.

The 2007 MMS Final *Programmatic Environmental Impact Statement for Alternative Energy Development and Production and Alternate Use of Facilities on the Outer Continental Shelf* (FPEIS) established the program, examined potential environmental effects of authorizing renewable energy and alternate use activities on the OCS, and identified policies and best management practices that may be adopted for the program (MMS 2007a).

The environmental compliance reviews required for leasing and plan approval processes for COPs for OSW developments are conducted under NEPA for major actions including: lease issuance, plan approval (General Activities Plan, SAP, and COP) and decommissioning activities. In addition to NEPA, environmental consultations include the Coastal Zone Management Act, Magnuson-Stevens Fishery Conservation and Management Act (Essential Fish Habitat), National Historic Preservation Act (Section 106), Endangered Species Act (Section 7), Clean Air Act, and the Migratory Bird Treaty Act. There are also a number of federal agencies in addition to BOEM involved in the offshore wind permitting process, including the U.S. Coast Guard (USCG), U.S. Environmental Protection Agency (USEPA), U.S. Fish and Wildlife Service (USFWS), NOAA National Marine Fisheries Service (NMFS), U.S. Army Corps of Engineers (USACE), U.S. Federal Aviation Administration (FAA), U.S. Geological Survey (USGS), and Department of Defense (DoD). Relevant regulations are briefly outlined below.

Renewable Energy Program Regulations (30 CFR 585). BOEM engages key stakeholders throughout this process, as early communication with interested and potentially affected parties is critical to managing potential conflicts. BOEM's renewable energy regulations were updated in October 2011 to reflect the Bureau reorganization, and will be updated in the future to incorporate lessons learned and stakeholder feedback. In 2016, BOEM published guidelines for *Information Requirements for a Renewable Energy Site Assessment Plan (SAP)* (BOEM 2016a) to clarify and supplement information requirements for SAP submittals.

As described in 30 CFR 585.620, a COP submitted to BOEM should describe "construction, operations, and conceptual decommissioning plans under a commercial lease, including the project easement." To this end the COP must include the following:

- All planned facilities that will be constructed as part of the OSW facility, including onshore and support facilities and all anticipated project easements.
- All proposed activities including construction activities, commercial operations, and conceptual decommissioning plans for all planned facilities, including onshore and support facilities.

BOEM approval must be achieved prior to construction of any OSW facility activities on a lease.

Furthermore, a COP must demonstrate that proposed activities comport with the following (30 CFR 585.621):

- Activities conform to all applicable laws, implementing regulations, lease provisions, and stipulations or conditions on the commercial lease and are safe.
- Activities do not unreasonably interfere with other uses of the OCS, including those involved with National security or defense.
- Activities do not cause undue harm or damage to natural resources; life (including human and wildlife); property; the marine, coastal, or human environment; or sites, structures, or objects of historical or archaeological significance.
- The COP includes use of best available and safest technology, best management practices, and use of properly trained personnel.

- The COP must include the results of surveys and studies conducted as part of the SAP for the lease area.

National Environmental Policy Act of 1969. A full analysis of potential impacts on the environment for any major commitment of federal resources is required by the federal government, BOEM in the case of OSW in the federal waters of the OCS. For offshore wind, issuing leases on the OCS is thought to represent such a commitment. Government agencies generally meet this review requirement by preparing an Environmental Assessment (EA) or an Environmental Impact Statement (EIS). An EA is a less detailed analysis for those actions that have no potential significant impact. Actions that may result in significant impacts are required to be analyzed through an EIS to complete the NEPA process, which typically takes from 18–24 months. Offshore wind projects on the OCS will generally require the completion of an EIS and issuance of a Record of Decision (ROD) regarding the COP. Earlier development phases, such as installation of meteorological buoys and meteorological towers and site characterization surveys, typically require an EA.

Endangered Species Act of 1973 (50 CFR 17). Federal agencies must consult with the USFWS and NOAA NMFS when reviewing any activity that may result in a "take" of any species listed as threatened or endangered or when proposed activities may affect their critical habitats. Marine mammals will also be treated under the Marine Mammal Protection Act (see below).

Marine Mammal Protection Act of 1972 (50 CFR 18). The "take" of marine mammals in U.S. waters by U.S. citizens would be a violation of the Marine Mammal Protection Act. Offshore wind developers would apply for a Letter of Authorization or Incidental Harassment Authorization and detail the potential species affected, mitigation measures, and monitoring and reporting requirements.

Coastal Zone Management Act of 1972. Federal activities, or federally permitted activities, affecting resources in a coastal zone must be consistent with a federally approved state coastal zone management plan. The designated state authority must determine that state and federal regulations are consistent with regard to the proposed activity, such as an offshore wind project or transmission cable.

Magnuson-Stevens Fishery Convention and Management Act. The Act requires the protection of important habitats of federally managed fish species (Essential Fish Habitat). Federal agencies are required to consult with NMFS regarding the potential effects of their actions on Essential Fish Habitat, and respond in writing to NMFS' recommendations. The project proponent generally prepares an Essential Fish Habitat assessment and submits it to the agency for the required consultation with NMFS.

National Marine Sanctuaries Act (15 CFR 922). The Secretary of Commerce establishes marine sanctuaries to protect marine resources. Offshore wind projects may not be built in any designated marine sanctuaries, and the potential effects on any nearby marine sanctuaries must be reviewed.

Clean Water Act. Under Section 404, the Clean Water Act requires a permit from the USACE for the discharge of dredged or fill materials into U.S. waters. A dredge and fill permit may be required for the construction of offshore wind turbines and for any buried transmission lines offshore or within the mean high water line of the shore. USACE Nationwide Permits (developed under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act) are applicable to site characterization and assessment activities (permit numbers 5 and 6, for scientific measurement devices and survey activities, respectively) and activities related to construction and operations, such as minor dredging (permit number 19).

Rivers and Harbors Act of 1899. Section 10 requires that regulated activities conducted below the Ordinary High Water elevation of navigable waters of the US be approved/permitted by the USACE. Regulated activities include the placement and removal of structures, work involving dredging, disposal of dredged material, filling, excavation, or any other disturbance of soils/sediments or modification of a navigable waterway. Navigable waters of the US are those waters that are subject to the ebb and flow of the tide shoreward to the mean high water mark or are presently used, have been used in the past, or may be susceptible to use to transport interstate or foreign commerce. Developers can use the Clean Water Act permitting process described above for compliance as there is a combined Section 404/Section 10 permit application.

Estuary Protection Act. The Act requires federal agencies, in planning for the use or development of water and related land resources, to give consideration to estuaries and their natural resources. Federal agencies, including the USACE, must include a discussion of the effects to estuaries for any planned projects in reports to Congress.

Migratory Bird Treaty Act of 1918. The Act implements conventions signed between Canada, the U.S., and Mexico to protect species of migrating birds, which covers all birds except exotic, introduced species. Incidental take permits are not available to project proponents. Impacts on migratory birds are avoided, minimized, and mitigated where practicable.

Bald and Golden Eagle Protection Act. The Bald and Golden Eagle Protection Act protects Bald and Golden Eagles specifically and is under the authority of the USFWS.

Clean Air Act. While the power generated by offshore wind turbines may not be associated with any air emissions, emergency generators at the site or vessels used during construction may require an air permit from the Environmental Protection Agency.

State and local laws. Due to the complex and varying nature of state and local laws and authorizations there are additional permits, consultations or approvals that may apply to offshore wind projects or related activities. These are likely to be triggered by projects located in state waters or as a result of cables that may be interconnected to shore (passing through state waters) from projects located in federal waters.

1.2 Status of Offshore Wind Development on the U.S. Atlantic OCS

At the time of this white paper, no OSW facilities have been installed in U.S. federal waters, although Rhode Island's Block Island project was constructed within state waters. Consequently, data on the actual environmental and siting effects of offshore wind energy facilities and on the installation, operations, and maintenance of OSW facilities in the U.S. are limited.

To date, BOEM has awarded 11 commercial wind energy leases off the U.S. Atlantic: two noncompetitively issued leases (one for the proposed Cape Wind project in Nantucket Sound offshore Massachusetts and one offshore Delaware) and nine competitively issued leases (two offshore Rhode Island-Massachusetts, two offshore Massachusetts, two offshore Maryland, two offshore New Jersey, and one offshore Virginia; and one pending but not yet awarded offshore New

York). In December 2016, BOEM announced a competitive auction for a WEA offshore North Carolina that is planned for March 2017 and it is expected to hold an additional competitive auction for a WEA offshore South Carolina in 2017. To date, numerous EAs have been prepared for the lease of WEAs in federal waters for site characterization and site assessment activities related to siting OSW facilities on the OCS. Relevant NEPA documents reviewed are listed below.

- The Cape Wind Energy Project was proposed by Cape Wind Associates, LLC in November 2001. The proposed project capacity was 468 megawatts (MW), with an average anticipated output of 174 MW. The USACE assumed the lead federal regulatory role under the River and Harbors Act, and issued a draft EIS in November 2004 prior to BOEM's involvement. The former MMS assumed lead federal responsibility following the Energy Policy Act of 2005. In September 2005, Cape Wind applied for a commercial lease for the project. The DOI announced the availability of the ROD in 2010 and in the same year, Cape Wind was issued the nation's first commercial least for construction and operation of an OSW facility. On February 26, 2015, Cape Wind submitted a request for a 2-year suspension of the operations term of its commercial lease. BOEM approved the lease suspension on July 24, 2015, and issued a suspension order pursuant to 30 CFR 585.418.
- A revised EA for Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore Rhode Island and Massachusetts was issued in 2013 (BOEM 2013a).
- Construction is completed on the first OSW facility in the U.S., which is owned and operated by Deepwater Wind. The five-turbine, 30 MW facility is in state waters about 3 nautical miles southeast of Block Island and is expected to power about 17,000 homes and at the time of this white paper was anticipated to begin generating power by the end of 2016. The Block Island OSW facility includes 8 miles of transmission line that cross federal waters, for which BOEM granted a right-of-way. USACE was the NEPA lead agency as part of its Clean Water Act Section 404 Permit authority. BOEM did not conduct a separate NEPA analysis for the COP because the project is in state waters. However, BOEM was a cooperating agency for NEPA analysis and consultations (USACE 2014).
- A final EA and Finding of No Significant Impact (FONSI) were issued in 2012 for leases offshore New Jersey, Delaware, Maryland, and Virginia (BOEM 2012). In 2015, two leases for offshore New Jersey wind development were acquired.
- The Revised EA and FONSI for a commercial wind lease issuance and site assessment activities on the OCS offshore New York were issued in October 2016 (BOEM 2016b).
- The revised EA for Virginia Offshore Wind Technology Advancement Project (VOWTAP) on the Atlantic Outer Continental Shelf Offshore Virginia was issued in 2015 (BOEM 2015). Construction bids for two wind turbines with a 6 MW capacity 24 nautical miles off the coast for the Virginia Offshore Wind Technology Advancement Project are underway. In March 2016, the Research Activities Plan for the first OSW facility research lease was issued to the Virginia Department of Mines, Minerals and Energy.
- The revised EA and FONSI for Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore North Carolina was issued in 2015 (BOEM 2015).

- An EA for Lease Issuance for Wind Resources Data Collection on the Outer Continental Shelf Offshore Georgia was issued in 2014 (BOEM 2014a). Georgia Power applied for three leases offshore to conduct wind viability tests, two of which remain in review.
- The revised EA and FONSI for Lease Issuance for Marine Hydrokinetic Technology Testing on the Outer Continental Shelf Offshore Florida were issued in 2013 (BOEM 2013b). On May 31, 2016, Florida Atlantic University Southeast National Marine Renewable Energy Center submitted an application to relinquish their Interim Policy Lease OCS-A 0495.

1.3 Need for Improving Efficiency in Offshore Wind NEPA Analyses

Scientific American reported in 2016 that "Where U.S. developers face the greatest risk of failure is in the regulatory arena, where offshore energy activities are subject to a unique set of requirements and regulations" (Cusick 2016).

The development of offshore wind projects in the U.S. has met significant obstacles over the past decade, and construction of a commercial -scale offshore project has not yet occurred. Challenges and opposition are rooted in technical disputes on potential environmental impacts and, potentially more important, local concerns about aesthetic and other impacts. To this end, as of February 2016, BOEM has conducted NEPA processes for site characterization and site assessment activities for almost all states along the OCS (except the South Carolina EA, which was underway at the writing of this white paper) and issued 12 commercial wind energy leases on the U.S. Atlantic OCS. Additionally, a lease sale for a WEA offshore North Carolina is planned for March 2017. As the NEPA process for the various states proceeded, BOEM relied upon earlier analyses (e.g., EAs in other states, and the Atlantic OCS Proposed Geological and Geophysical Activities Mid-Atlantic and South Atlantic Planning Areas Final Programmatic Environmental Impact Statement, BOEM 2014b), among other BOEM documents, to try to reduce the length of the documents, avoid repetitive analyses, and focus on site-specific effects in the more recent EAs. Even so, recent EAs such as those for North Carolina or Massachusetts ended up to be 300 to 400 hundred pages in length and the New York EA, which received a FONSI in October 2016, was over 300 pages in length excluding appendices.

In an effort to find efficiencies in future NEPA analyses related to offshore commercial-scale wind facilities, BOEM issued a Request for Proposal that requested development of a series of white papers organized by resource. The white papers are intended as a mechanism to update capabilities for new information and to be incorporated within future NEPA documents by reference. This white paper reflects this approach for coastal habitats along the U.S. Atlantic coast.

1.4 Objective of White Paper for Coastal Habitats

The objective of this white paper is to provide an analysis of potential effects of OSW facility COPs on coastal habitats that would be part of a NEPA analysis related to COPs for commercial-scale wind facilities. This white paper is intended to identify effects of activities on coastal habitats that are common to COPs. To identify common COP activities and effects, an extensive literature review was conducted for coastal habitats on the U.S. Atlantic coast, effects on coastal habitats from OSW facility installation and operation in both the U.S. and Europe, and, due to lack of data on effects on coastal habitats from OSW facilities, effects from landfall activities with potentially similar effects on coastal habitats. Based on the literature review, the white paper determined that the focus of most OSW facility effects analyses (in Europe as well as in the U.S.) is related to offshore effects from wind turbine placement and operation. Consequently, it was determined that Cape Wind, VOWTAP, and Block Island be used to identify the majority of the COP activities to be included in the effects matrix template. It should be noted that the effects matrix template captures direct and indirect effects only and does not consider cumulative effects. However, the matrix is constructed so that it can be modified to accommodate the addition of cumulative effects, which will be useful as NEPA documents for OSW facility construction, operation, and decommissioning are completed.

An effects matrix template was developed to allow users (either BOEM or a wind developer) to take a logical step-by-step approach for each proposed COP activity that has common effects to: (1) scale the potential effect to coastal habitats and (2) make consistent and efficient effects determinations. Effects determinations in the matrix could then be used in future COP NEPA documentation. Those effects determinations that have been analyzed in a previous BOEM NEPA document and for which a FONSI or ROD has been issued, may be incorporated by reference. The matrix provides a means of updating and/or adding effects that have yet to be part of a NEPA document and FONSI or a ROD, as future COP NEPA documents are finalized. The matrix also provides a template that can be used for resources other than coastal habitats.

1.5 Scope of Analysis

The scope of this analysis is outlined below.

- Compilation of literature relevant to the affected environment and potential impacts resulting from COP activities on coastal habitat. This includes, but is not limited to, BOEM NEPA documents prepared for offshore or other energy development along the U.S. Atlantic OCS.
- Development of the affected environment to be evaluated within each wind resource Planning Area. For example, typical coastal habitats along the U.S. Atlantic OCS would first be identified so that they could be grouped by shoreline type and/or by the use of the habitat, such as tidal flats, beach, dunes, and maritime forest.
- Development of a list of COP activities that may occur within the affected environment. The analysis considered COP activities from the Cape Wind Energy Project, the VOWTAP Research Activities Plan (RAP), and Block Island projects. Cape Wind, for which the COP was originally submitted in 2011, has yet to be constructed and would install 130 3.6 MW wind turbines. Under current technology, it is unlikely that 3.6 MW wind turbines would be the choice of most wind developers and are unlikely to be utilized in the future. The VOWTAP RAP proposes two 6 MW turbines, but the project has not yet been constructed. The Block Island facility has been constructed and, at the time of this white paper, represents the first OSW facility in North America. Due to its timeliness and use of best available technology including installation of the larger-sized 6 MW wind turbines, the Block Island Environmental Report/Construction and Operation Plan[3] (hereinafter "Block Island ER/COP"; Tetra Tech 2012) and its associated NEPA

[3] The Block Island Environmental Report/Construction and Operation Plan prepared as part of the State permitting process for OSW. The project was developed to help meet Rhode Island's renewable energy standards under the

analysis prepared by the USACE (USACE 2014) have been relied upon heavily to identify the bulk of COP activities considered herein. Typical COP activities include offshore installation and operation of wind turbines and associated facilities, landfall for installation and expansion of ports and docks, vessel traffic during construction and operation, oil and chemical spills, and decommissioning.

- Identification of direct and indirect impacts on coastal habitats that may result from COP activities.[4] Activities that result in effects that are similar and likely to occur consistently for future commercial-scale wind facilities across the U.S. Atlantic OCS have been further refined and grouped together (effects common to future offshore wind facilities, hereinafter "common effects") including those effects that are determined to be negligible (no measurable effect). The common effects are evaluated for both context and intensity of impact on each resource area (or subset of resources within a resource area). This analysis was used to develop an overview of the likely range effects determinations to coastal habitats. Ultimately, identification of impacts or the range of impacts on the resource from common effects was compiled for inclusion in the matrix.

Developing context and intensity rankings for impacts relies on definitions already in use by BOEM for the leasing EAs and other NEPA documents, with modifications as necessary. A matrix was developed that provides the baseline for coastal habitats using measures of context, intensity, and duration. The baseline which was developed describes the affected environment of coastal habitats along the U.S. Atlantic coast of the U.S., using data layers from numerous sources. The matrix will apply all common effects to the baseline for coastal habitats and present the effects determination (or range of effects). The matrix includes effects that are already contained within an existing NEPA document for which a FONSI or ROD has been issued and provides a mechanism for determining whether additional analyses are necessary. Identifying COP activities that have common effects and assembling these effects in a matrix provides the platform for conducting an organized and efficient approach to effects determinations. Additionally, through development of such a matrix, data gaps have been identified that require further study or analysis.

Rhode Island Winds Program (RIWINDS), codified by Rhode Island State Legislations (RIGL §§ 39-26-1 et seq. and 39-26.1-7).

[4] Cumulative effects are outside the scope of the analysis contained in this white paper.

Chapter 2
Existing Information and Literature Review

Numerous documents and publications were reviewed for information relevant to the development of this white paper and matrix that address potential impacts on coastal habitats as a result of OSW facilities. Through this extensive review it was determined that the focus of the analysis for OSW facilities is generally on offshore impacts on benthic habitats and marine species including special-status or listed species rather than coastal habitats in both the U.S. and Europe. For example, a generalized impact assessment for Swedish waters by Bergstrom et al. (2014) found a strong focus on marine mammals, and to some extent fish. A review of Environmental Statements for offshore wind-farm developments (primarily from Denmark and the United Kingdom) by OSPAR (2008) identified the primary environmental impacts as "sea bed habitat loss/disturbance; fish; marine mammals; birds; seascape public perception, and cumulative impacts." The European Offshore Energy Strategic Environmental Assessment Program (DECC 2016) received specific comments referencing a "Lack of emphasis on coastal impacts" due to an absence of discussion regarding "possible impacts to coastal habitats from cables/pipes in the intertidal or when making landfall (impacts of tunneling under/through beaches, salt marshes and dunes)." Finally, with respect to research needs, Boehlert and Gill (2010) identified a lag in research behind offshore wind technology in northern Europe.

In the U.S., impacts on coastal habitats are typically considered negligible or minor, likely because landfall and onshore activities often occur in existing rights-of-way, currently developed areas, or previously disturbed areas and because of the small footprint associated with onshore activities, as described in the VOWTAP RAP (TetraTech 2015), Block Island EA (USACE 2014), and Cape Wind EIS (MMS 2009). For example, The VOWTAP RAP states "the proposed locations for all of the VOWTAP onshore facilities and associated construction right-of-ways and work areas are located in areas that have experienced some level of previous disturbance, including paved roads, maintained road shoulders, and gravel parking areas." Similarly, the Block Island EA states "onshore facilities have been primarily located along existing rights-of-way and in currently developed areas" and the Cape Wind EIS includes the statement "Onshore activities associated with installation of the transmission cable system would occur in existing ROWs (road or transmission line) within a developed region, and would therefore not result in loss of habitat." Following is a list of some of the document sources used in the literature review.

- U.S. federal agencies such as EISs and EAs prepared for the USACE for the first offshore wind project under construction in the U.S. at Block Island, Rhode Island, and for the delayed Cape Wind project.
- Documents prepared by the United Kingdom, Denmark, and Germany, for example the United Kingdom Department of Energy and Climate Change prepared the 2016 Offshore Energy Strategic EA.
- Private Industry, for example, DONG Energy prepared the EIS for the Burbo Bank Extension, the largest offshore wind facility in the world (DONG 2013).
- Not-for-profit organizations such as the Environmental Impacts of Offshore Wind Power Production in the North Sea: A Literature Overview, prepared by the World Wildlife Fund (WWF 2014).

- Peer reviewed journal publications addressing both general and specific components and effects of offshore wind energy, in journals such as Science, Oceanography, ICES Journal of Marine Science, Journal of Atmospheric and Oceanic Technology, Current Biology, Marine Pollution Bulletin, Electromagnetic Biology and Medicine, Renewable Energy, Estuarine Coastal and Shelf Science, The Scientific World Journal, and the Journal of Wildlife Management.

As of June 30, 2016, there were 3,344 offshore wind turbines with a combined capacity of 11,538 MW fully grid connected in European waters in 82 wind facilities across 11 countries, including demonstration sites (as reported by WindEurope 2016). During the first half of 2016, Europe grid connected 114 commercial offshore wind turbines with a combined capacity totaling 511 MW from four wind energy facilities, two in the Netherlands and two in Denmark. All are owned by Siemens and range in size between 3 and 6 MW. More than 91% (11,028 MW) of the world's offshore wind power is currently installed off northern Europe, in the North, Baltic and Irish Seas, and the English Channel (WindEurope 2016). Other statistics regarding offshore wind are listed below (Environmental and Energy Study Institute 2016).

- A cumulative total of 369,553 MW of wind energy capacity was installed globally by the end of 2014. Of that total, only 2% came from offshore wind facilities.
- The National Renewable Energy Laboratory (NREL 2010) has estimated the United States has over 4,000 gigawatts of offshore wind potential, enough to power the country four times over.

The U.K. Department of Energy and Climate change reported in 2016 that impacts of physical disturbances associated with oil and gas licensing and OSW facilities are expected to be negligible in comparison to natural disturbance and demersal fishing. Shoreline erosion impacts are considered as part of various studies (U.K. Department of Energy and Climate Change 2016; EMEC 2008) and a review by Clark et al. (2014) reports no evidence for "irreversible changes to shoreline deposition" due to OSW facilities on the North and Baltic seas. An earlier 2008 Environmental Impacts Assessment by the European Marine Energy Center (EMEC 2008) suggested that siting of onshore activities should avoid sensitive habitats and that recovery from degradation of these habitats could take more than 2 years (e.g. seabed excavations, erosion).

Other environmental evaluations of impacts of European OSW facilities focus on impacts on marine species as a result of acoustic disturbance, sediment disturbance, electromagnetic field (EMF), and physical impacts of turbines during the construction phase and more variable and localized impacts during the operation phase (e.g., Kaldellis et al. 2016; Bergstrom et al. 2014; Bailey et al. 2014; Clark et al. 2014; Wilson et al. 2010). These studies consistently referred to a need for more information regarding potential impacts of OSW facilities on the environment and, in 2016, one of Europe's largest generators of electricity (owned by the Swedish state), Vattenfal, announced a $3.3M scientific research program to "better understand the environmental impacts of offshore wind farms" emphasizing the need for more data and information regarding impacts of OSW facilities on the environment in general. Similar to the U.S. literature, literature related to OSW facilities in Europe focus primarily on offshore impacts; therefore, this white paper does not include extensive discussion on European OSW projects.

2.1 BOEM NEPA Evaluations Relevant to Coastal Habitats

As described in Section 1.1, BOEM's renewable energy program has four distinct phases: planning, leasing, site assessment, and construction and operations. Prior to issuing a lease, BOEM conducts a NEPA analysis of the potential effects associated with lease issuance, including site characterization and site assessment activities. The SAP describes proposed site assessment activities (e.g., construction of meteorological towers and/or buoys) in the lease area. SAP activities cannot begin until after completion of the NEPA process (typically an EA and FONSI), after which the lease sale occurs. Site characterization includes geophysical, geotechnical, archaeological, and biological survey work as well as installation of meteorological towers and/or buoys. Once a lessee submits a COP, BOEM would also conduct a separate site- and project-specific NEPA analysis associated with the construction and operation activities.

This information is used to determine whether the site is suitable for commercial development. If so, a lessee may submit a COP with its project-specific design parameters for BOEM's review. BOEM considers the merits of the COP; performs the necessary consultations with the appropriate state, federal, local, and tribal entities; solicits input from the public and the relevant stakeholder task force; and performs an independent, comprehensive, site- and project-specific NEPA analysis for the COP. This separate site- and project-specific NEPA analysis may take the form of an EIS and provides additional opportunities for public involvement pursuant to NEPA and the Council on Environmental Quality regulations at 40 CFR 1500–1508. BOEM uses this information to evaluate the potential environmental and socioeconomic consequences associated with the lessee-proposed project, when considering whether to approve, approve with modification, or disapprove a lessee's COP pursuant to 30 CFR 585.628 (as discussed in Section 1.1). At the time of preparation of this white paper, no COP other than Cape Wind has been submitted to BOEM for review and analysis under NEPA. The Cape Wind final EIS and ROD were issued in January 2009 under MMS. As discussed in Section 1.1, final regulations for Title 30 CFR 585 were promulgated on April 22, 2009 and the creation of BOEM and the BSEE did not occur until 2010.

Although at the time of this white paper no other COPs have been submitted to BOEM, leases for development of OSW energy have been acquired and/or are being pursued for development in U.S. Atlantic coastal states. The EAs prepared for leases for site assessment and site characterization activities were outlined earlier in Section 1.2. Each of these documents includes an Affected Environment section. Because site assessment and site characterization activities do not typically involve onshore activities (other than vessel use at existing ports and marinas), these EAs included only a cursory analysis of coastal habitats in the Affected Environment sections.

As described previously, Rhode Island's Block Island project is the only OSW facility in the U.S. but is not located in federal waters. The Cape Wind COP indicates the proposed cable landfall would be within an existing right-of-way to avoid effects on coastal/intertidal habitats (MMS 2012). Therefore, the absence of BOEM analyses relevant to the effects of COPs on coastal environments is not unexpected. Other NEPA documents that address impacts on coastal habitats include those that address cable and pipeline impacts in estuarine and nearshore environments. One is the EIS for Proposed Geophysical and Geological Activities in the Atlantic OCS to Identify Sand Resources and Borrow Areas (BOEM 2014c), which identifies new cable infrastructure installation as "Reasonably Foreseeable Future Actions within the Study Area." The Programmatic EIS for the OCS oil and gas leasing program (DOI and BOEM 2012) identified subsea cables as a source of potential subsea noise and vibration and bottom sediment disturbance (turbidity and contaminant resuspension) of coastal habitats and marine and coastal fauna. Consequently, results of these documents are presented here due to similarity of potential impacts to those that may be anticipated as a result of OSW facilities and activities.

References to coastal habitats in the EAs and EISs for U.S. projects (described in Section 1.2) were minimal at best. Within those documents, intertidal habitat was referenced more frequently with respect to estuarine areas. Most of the documents focused primarily on marine species (benthic organisms, fisheries, sea turtles, birds, bats, and marine mammals), which are not the focus of this white paper. Potential impacts on species and habitats were considered negligible in most evaluations based on the landfall occurring in an already developed location or existing right-of-way. The extremely small footprint of areas of potential impacts on coastal habitats, when compared with the large marine footprint of the offshore wind turbine generator (WTG) components, may also influence the evaluation of impacts. Potential impacts on onshore resources were addressed briefly for terrestrial birds and mammals with respect to substation construction and overhead transmission lines.

In the ROD issued for the MMS FPEIS (MMS 2007b), the U.S. Atlantic coast was divided into four planning areas, which include the North Atlantic (from Maine south to include the New Jersey coast), the Mid-Atlantic (from Delaware south to include the coast of North Carolina), the South Atlantic (from the coast of South Carolina south to approximately Cape Canaveral, Florida), and the Straits of Florida (extending from around the southern tip of Florida about 200 kilometers [125 miles] into the Gulf of Mexico). The MMS FPEIS (MMS 2007a) includes a relatively brief (six pages) section titled Coastal Habitats that references several coastal habitats along the U.S. Atlantic coast and differentiates generally among the three planning areas. The coastal habitats called out include beaches, wetlands, and adjacent uplands in general. More specific references include shorelines (rocky shores, sand and gravel beaches, and mudflats), sand beach-dune and/or barrier beaches, maritime forests, fresh and saline tidal marshes, shrub swamps and tidal forests, estuaries, and nearshore benthic areas.

The 2009 EIS prepared for the Cape Wind project provides descriptions of habitats, primarily by species. No specific section on coastal habitats is included in the Final EIS or associated project EAs, although the section titled "Coastal and Intertidal Vegetation" (three pages) included subsections for flora, barrier islands, beaches, and dunes; brackish and saline wetlands; and seagrass beds.

The Block Island EA was prepared by the USACE (USACE 2014) with BOEM as a cooperating agency due to cable transmission right-of-way located within federal waters. It does not specifically address coastal environments except with respect to individual species consultations and where wetlands jurisdiction applies.

BOEM EAs for lease issuance have been limited in the extent or type of activities examined with respect to coastal habitats due largely to the fact that no landfall or other shoreline activities are proposed as part of surveys, or a typical SAP. The BOEM documents reviewed for this white paper referenced "coastal habitats" specifically, but only in reference to the MMS FPEIS (MMS 2007a) or to the extent that it was relevant to the ecology of a particular species. For example, the Massachusetts EA for Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf (BOEM 2014d) included four pages of discussion of the affected environment for coastal habitats and associated potential impacts, while the others were less extensive. The Florida, NC, and mid-Atlantic states EAs referenced the MMS FPEIS (MMS 2007a) for coastal habitats descriptions, for example, "The general description of coastal habitats along the U.S. Atlantic Coastal Plain are incorporated here by reference and can be found in Chapter 4.2.13 of the MMS FPEIS (MMS 2007a) and summarized in this section", followed by brief descriptions of specific areas. Most of the Affected Environment was presented with respect to listed species. Each of the EAs listed coastal habitats that were considered in the development of the matrix prepared for this white paper.

Similarly, Kaplan et al. (2011) prepared a literature synthesis for the north and central Atlantic that describes the habitats specific to birds and fish, for example, but not the habitats themselves. A scientific review of potential environmental impacts of offshore wind energy by Wilson et al. (2010) concluded that while not environmentally benign, the environmental impacts of OSW facilities are generally minor and can be mitigated through good siting practices.

2.2 SAP Activities from BOEM NEPA Documents Relevant to Coastal Habitats

BOEM provides guidelines to clarify information requirements for SAP submittals and to explain the applicable provisions of BOEM's renewable energy regulations (per 30 CFR 585). BOEM requires the results of site characterization studies to be submitted with the SAP pursuant to 30 CFR 585.610(b) to evaluate the impact of proposed activities on physical, biological, and socioeconomic resources as well as the seafloor and sub-seafloor conditions that could be affected by the construction, installation, and operation of facilities and supporting structures (e.g., meteorological towers and buoys). Information and data from the SAP phase pertinent to OSW COPs include activities with effects similar to those of OSW facility projects, such as vessel-induced waves, drilling discharges, and the potential for fuel or lubricant spills. In addition, information and data gathered as part of SAP activities are used to help inform OSW facility design and siting as well as development of avoidance and minimization measures that can be implemented as part of future COPs.

A SAP includes the lessee's detailed proposal for the construction and operation of a meteorological tower(s) and/or meteorological buoys on the leasehold. See 30 CFR 585.605–585.618. The lessee's SAP must be approved by BOEM before it conducts these "site assessment" activities on the leasehold. BOEM may approve, approve with modification, or disapprove a lessee's SAP. See 30 CFR 585.613.

Relevant SAP activities include wave erosion due to vessel activities, along with contamination due to potential spills and onshore activities related to fabrication, staging, and launching of crew/cargo vessels for tower and buoy installation, although activities typically occur at existing ports or industrial areas capable of supporting these activities. Previously developed EAs for site assessment and site characterization s report no anticipated expansion of existing facilities (e.g., Mid-Atlantic, North Carolina). On-site inspections and maintenance (i.e., marine fouling, wear, and lens cleaning) are expected to occur on a monthly or quarterly basis and equipment is likely solar operated, thereby reducing opportunities for spills. Vessel traffic associated with operation and maintenance would increase the amount of wave erosion occurring prior to installation. Decommissioning activities would include similar vessel traffic, and onshore activities (e.g., de-assembly and delivery to receiving port) would be expected to occur at existing facilities and be temporary. Recent SAP EAs for the U.S. Atlantic Coast are summarized below.

- The Massachusetts EA concluded "No direct impacts on wetlands or other coastal habitats would occur from routine activities in the WEA based on the distance of the WEA from shore.

Existing ports or industrial areas in Massachusetts, Rhode Island, and Connecticut are expected to be used in support of the proposed project. In addition, no expansion of existing facilities is expected to occur as a result of Alternative A. Indirect impacts from routine activities may occur from wake erosion and associated added sediment caused by increased traffic in support of the proposed action. Given the volume and nature of existing vessel traffic in the area, a negligible increase of wake-induced erosion may occur. Should an incidental diesel fuel spill occur as a result of the proposed action, the impacts on coastal habitats are expected to be negligible."

- The Mid-Atlantic states EA, with respect to "Mid Atlantic Coastal Habitats" indicated "Since no expansion of existing onshore facilities is expected to occur as a result of Alternative A, impacts from routine activities would be limited to a negligible increase, if any, to wake induced erosion around the smaller, non-armored, waterways that may be used by project-related vessels. Impacts to coastal habitats from an accidental diesel fuel spill, should one occur, would likely be negligible, localized, and temporary."
- The North Carolina EA concluded that "No direct impacts on coastal habitats are anticipated from routine or non-routine activities in the WEAs due to the distance of the WEAs from shore. Existing ports or industrial areas are expected to be used in support of Alternative A. In addition, no anticipated expansion of existing facilities is expected to occur as a result of Alternative A. Therefore, impacts on coastal habitats would be negligible."

2.3 Other Analyses Applicable to Coastal Habitats

Recent evaluations of coastal habitat disturbance prepared by other federal agencies (e.g., NOAA, USFWS, USEPA) were reviewed for impacts on coastal habitats that may be relevant or similar to those anticipated from OSW projects. In general, impacts were reported as minor to moderate and temporary. Conclusions and/or excerpts from recent federal agency EISs that may have some impacts similar to those of OSW facilities with respect to actions in coastal habitats are presented below.

Final Programmatic Damage Assessment and Restoration Plan and Final Programmatic Environmental Impact Statement (PEIS) for the Deepwater Horizon oil spill (NOAA 2016b). While this PEIS does not include cables or offshore energy, it is concerned with short-term coastal construction activities particularly related to coastal area restoration or recreation projects. The PEIS is very general due to its programmatic nature and reports, "Short-term and long-term, minor to moderate adverse impacts … could result from construction activities related to creating, restoring, and enhancing coastal wetlands. Short-term impacts could result from the use of staging areas (causing water turbidity from sediment disturbance) and construction equipment (releasing emissions causing adverse air quality and noise impacts from the operation of machinery)." Construction activities "could also result in localized, permanent, adverse impacts to shallow intertidal or subtidal habitat—such as that for [submerged aquatic vegetation] or oysters, for instance, if fill is placed in these areas to create marsh. These impacts are expected to be confined to the immediate vicinity of the project, and best practices would likely be implemented to minimize adverse impacts."

Final New England Clean Power Link Project EIS for New England Clean Energy (DOE 2015). Although not coastal, this project identifies impacts on "both aquatic (underwater) and terrestrial (primarily underground)" as a result of transmission cables for the proposed electrical transmission line from Canada to Vermont. This project proposed water-based construction activities, transmission cable installation, ancillary equipment use, and support activities in Lake Champlain, including installing aquatic transmission cables using jet-plowing, a cable-laying vessel or barge, and smaller vessels operated to support crew shift changes, deliver supplies, refuel equipment, and supervise work. The transmission line cables would be delivered to the installation vessel via barges traveling through the Champlain Canal. Minor, local, and temporary impacts on water quality, aquatic habitats, and terrestrial habitats were anticipated as a result of cable installation, operation, and maintenance.

Final Environmental Impact Statement on the Rockaway Delivery Lateral and Northeast Connector Projects (FERC 2014). The proposed project is a new gas pipeline extending from an offshore interconnect in the Atlantic Ocean to an onshore delivery point with a system on the Rockaway Peninsula in Queens County, New York. Federal Energy Regulatory Commission staff concluded that implementation of the proposed projects would result in some adverse environmental impacts associated with offshore construction related to archaeological resources, air quality and noise (pile driving), and cumulative impacts. Horizontal directional drilling (HDD) would be employed to avoid impacts on beach habitats, and impacts on nearshore benthic communities (sediment disturbance) would be reduced to less-than-significant levels as a result of proposed/recommended minimization and mitigation measures. Specific effects on water quality, benthic habitat, beach, salt marsh, and coastal scrub/shrub were considered short term and temporary and not significant in the context of mitigation measures.

Disturbance of beaches, dunes, or other coastal habitats by the onshore interconnection cable and fiber optic cable may result in direct habitat losses from excavation as well as indirect impacts such as the occurrence of pollutants from an accidental loss of drilling fluids from HDD activities. Onshore facility construction along existing roads and rights-of-way or within previously disturbed areas would reduce impacts from construction of facilities and likely result in negligible to moderate impacts on coastal habitats. Also, state and federal regulations typically preclude siting onshore facilities in locations where sensitive coastal resources occur. Habitat loss has been identified as one of the major threats to marine biodiversity, although the prevailing focus tends to be on species richness (Dulvy et al. 2003; Airoldi et al. 2008).

Similarly, while NEPA documents per se did not address coastal habitats closely, some support documents prepared for the projects did, e.g., the Critical Issues Analysis prepared to support the siting and development of the Block Island Transmission System for Deepwater Wind Block Island Transmission, LLC (TetraTech 2012) provided additional information on the affected environment. In fact, some documents suggested the "coastal and onshore portions of the route present the greatest environmental and permitting challenges" (TetraTech 2012). Additional academic, technical, and support publications reviewed recommend avoiding sensitive areas and acquiring more data, specifically baseline and monitoring data specific to the location of the proposed facilities, to inform decision-making (Busch and Garthe 2016; Bailey et al. 2014; Shumchenia et al. 2012; McCann 2012). For example, a 2015 BOEM study reports, "Currently, the site specific project data needed to evaluate the potential impacts on fisheries resources in these WEAs is lacking, resulting in uncertainty and speculation" (Petruny-Parker et al. 2015). NEPA documents, without site-specific data and/or information, typically recommend avoiding sensitive areas and working in existing rights-of-way.

Programmatic and project-specific analyses for EISs conducted under NEPA have identified many of the potential issues of concern that may be raised by individual offshore wind energy development proposals. In conducting the programmatic environmental studies necessary to issue permits or leases for offshore wind projects, BOEM's predecessor agency identified potentially affected resources, including: terrestrial, coastal, and underwater flora and fauna; habitat areas including marine sanctuaries and critical habitat areas. An analysis of impacts on the Atlantic herring fishery (NOAA/NMFS 2005) concluded that installation of pipelines, utility lines, and cables can have direct and indirect impacts on offshore, nearshore, estuarine, wetland, beach, and rocky shore coastal habitat zones and impacts on shallow water habitats are more likely to be adverse when compared with open water due to greater biomass by impacts in right-of-way (Johnson et al. 2008). The installation of cable transmission lines incorporates methods similar to those used in pipeline projects, including plowing and trenching, which affect shellfish beds, hard-bottomed habitats, and submerged aquatic vegetation (SAV) (Gowen 1978; Mills and Fonseca 2003). Discharge of contaminants due to spills associated with onshore activities (Carlton 2001) and the introduction of nonnative/invasive species (TetraTech 2015) can adversely affect nearshore and coastal environments if not managed well. Similar impacts of sediment disturbance, i.e., "Impacts to tidal freshwater wetlands and brackish marshes would occur as a direct result of sediment removal and the physical act of dredging. The primary effect of disturbing the sediment...would be displacement of benthic and demersal species" (USACE 2012).

Burial and installation of submarine cable arrays, as well as cable maintenance, repairs, and decommissioning can affect benthic habitat through temporary disturbance from plowing and from barge anchor damage and adversely affect SAV (Johnson et al. 2008). Most of fluidized sediment would settle back into the trench to provide cover for the cable, a portion of the fine sediments (<200 µm) could remain in suspension under the influence of the ambient currents. The zone of influence for the trenching activities would be widest near the shore where current velocities are highest and narrowest offshore where current velocities are less. The plume height would be less than a tenth of a meter at the edge of the plume. Depending on the mobility of sediment transport from local ocean currents and the volume of sediment disturbed, jet plowing and remotely operated vehicle (ROV) jet trenching effects to water quality would result in temporary sediment suspension localized within the water column.

Most of these impacts are considered relatively short term and should subside after construction is completed. Increased sedimentation and turbidity during the decommissioning could be greater than the construction impacts if all submarine structures were to be removed (Johnson et al. 2008) and decommissioning is anticipated to result in moderate but temporary impacts on benthic resources (TetraTech 2015). Full recovery of the benthic community to pre-construction conditions following decommissioning is anticipated to take 3 months to 2.5 years (TetraTech 2015). Spills of hazardous materials that may be stored or used, such as fluids from transformers, diesel fuel, oils, greases and coolants for pumps, fans and air compressors, can also affect water and sediment quality.

All of these studies indicate that construction activities should not take place in important sensitive areas, activities should occur in existing rights-of-way, and seasonal sensitivity of habitats should be considered when planning activities. Studies on the operational phase have mainly documented the colonization and aggregation of species close to the foundations, during the first years after establishment (e.g., Wilhelmsson et al. 2006; Maar et al. 2009). Studies on acoustic disturbance have predominantly approached effects on habitat use of harbor porpoise (Scheidat et al. 2011; Teilmann and Carstensen 2012). Research has not focused on coastal habitats (Airoldi et al. 2008; Bergstrom et al. 2014).

2.4 Available Spatial and Mapping Data

The data compiled for this report are intended to provide broad set of resources for assessing the coastal habitats described within this section. Due to the length of these lists, they have been provided as a series of tables in Appendix A. Data considered for inclusion are publicly accessible and, as a general rule, mapped to at least the state level. Where smaller-scale data sets offered a more current resource or were the sole source for a particular habitat within a state, these data were included. Large-scale national and regional efforts provided important sources for many of the habitats and these included datasets published by NOAA, USFWS, USGS, and The Nature Conservancy and included ESI atlases, the National Wetlands Inventory, National Gap Analysis Program Land Cover Data Version 2, and data products from the Northwest Atlantic Marine Assessment. The ESI atlases, in particular, were seen as a valuable data resource from Maine to Georgia, as the release of updates to these states began in 2014 and are expected to be completed with all data made publicly accessible by early 2017. In many cases, the links to datasets provided in the effects matrix and in Appendix A will require the user to further specify a particular dataset or region, rather than link to the specific page for downloading the data. This was done so that users may observe where more recent data may have been published since the time of writing. Additionally, many of the datasets listed below may be accessed or downloaded from regional geographic information system interactive map portals and data catalogs. However, these portals may not be as current as the data provided by the publisher and so have been excluded from this effort.

Chapter 3
Atlantic OCS Affected Environment

The MMS FPEIS (MMS 2007a) includes the following general description of the U.S. Atlantic coast: "The U.S. Atlantic Coast region is a low-lying area composed of a variety of coastal features, including mainland shores, delta plains, estuaries and bays, lagoons, barrier islands and capes, and tidal inlets. In the glaciated coasts of the north (from the United States-Canada border to New York City), the shorelines are deeply indented and bordered by numerous rocky islands. Glacial erosion has created embayments with straight sides and deep water. The central and south coastal region is characterized by continuous barrier islands and capes (spits) interrupted by inlets and large embayments with drowned dendritic river valleys (e.g., Delaware Bay and Chesapeake Bay). Extensive wetlands and marshes occur in areas where sediment and marsh vegetation have partially filled the lagoons behind barrier islands (Morton and Miller 2005; USACE 2002). In the southeastern coastal region, barrier islands change in composition from quartz sand to carbonate sand because the shelf is mainly carbonate (coral reef). The Florida Keys are remnants of coral reefs that developed during the last interglacial period when sea level was higher. Live reefs currently grow to the east and south of the keys (Morton and Miller 2005; USACE 2002)."

This white paper categorizes the range of geologic, hydrologic, and topographic characteristics found along the U.S. Atlantic coast into 11 habitat types. These include:

- Coastal uplands
- Dunes
- Beaches
- Salt/brackish water wetlands
- Tidal flats
- Rocky intertidal zone
- SAV
- Shellfish reefs
- Nearshore hard bottom
- Nearshore soft bottom
- Water column

The habitats and their geographic range within states and planning areas are listed in Table 3-1. The following section provides a more detailed description of the defining characteristics of these habitats and the anthropogenic threats they face. Finally, individual sections set within each of the four Atlantic BOEM Planning Areas are used to describe the distribution and highlight unique aspects of these habitats within the planning regions.

The geographic area of interest that limits the inland and seaward extents of habitats discussed within this section corresponds to the boundaries of the Atlantic OCS BOEM planning areas (Figure 3-1). The seaward extent is defined by the state waters (3 nautical miles in most states and 9 nautical miles in Florida) of the U.S. Atlantic coastal states and the landward extent includes marine and estuarine coastal habitats adjacent to these shorelines in addition upland habitats that they abut. Only Atlantic waters are considered in the Straits of Florida Planning Area, defined as waters south and/or east of U.S. Highway 1 in the Florida Keys.

Table 3-1. Coastal Habitats Described as Part of the Atlantic BOEM Planning Areas

These are intended to be only brief summaries with a more in-depth discussion of habitat characterization and variations in distribution across planning areas discussed in Section 3.1, *Descriptions of Coastal Habitats*, and Section 3.2, *Environmental Characterizations of Atlantic BOEM Planning Areas.*

Habitat	Key Divisions	General Description
Coastal Uplands	none	A diverse range of ecosystems from spruce-fir maritime forests in Maine to tropical hardwood hammocks in the Florida Keys. Work begun by Omernik (1987) that has since undergone several revisions recognizes six Level III ecoregions, whose descriptions are a standard reference to describe the natural breaks in upland and coastal systems.
Dunes	none	Mounds of unconsolidated sandy soils and are differentiated from beaches by their vegetative communities (VIMS 2009). Dunes are dynamic features that change in height and are reworked as wind moves sand along the beachfront and storm surges overwash the dune habitat. Dunes consist of a primary dune that is closest to the ocean and secondary dunes that occur further inland.
Beaches	none	Beaches consist of unconsolidated sediments of various sizes (or biogenic material, in the case of shell beaches) that are constantly moving due to the influence of waves and wind. Because of this, beach faces may change seasonally as wind and wave exposure change and the beaches erode and accrete accordingly (VIMS 2009). Beaches may be present along estuarine and marine shorelines.
Salt/ Brackish Water Wetlands	*Salt marshes*	Salt marshes are common estuarine habitats found in temperate and subtropical environments from Maine to Florida. The composition of the plant community within salt and brackish marshes is highly influenced by slight differences in elevation; as such, slope and elevation are defining aspects of these habitats.
	Mangroves	Mangroves form subtropical forested wetlands that occur in marine-freshwater areas of Florida. Mangroves are among the most highly productive coastal habitats. The prop roots, trunks, and pneumatophores provide a vegetative reef surface in the subtidal and intertidal zones, providing shelter and foraging areas for an estimated 1,300 species (USFWS 1999).
Rocky Intertidal	none	Intertidal habitats primarily found from Maine to Massachusetts. They are characterized by sharp environmental gradients, ranging from the low rocky intertidal zone to upper intertidal zone (Tyrell 2005).
Tidal Flats	none	Tidal flats are normally associated with inlets, estuaries, or shallow bays and are classified as unconsolidated shores, which can be composed of sandy and/or muddy sediments.

Habitat	Key Divisions	General Description
Submerged Aquatic Vegetation	none	Comprise marine, estuarine, and riverine rooted, vascular plants that can be separated into communities based on salinity. Eelgrass is the dominant species in seagrass beds from Maine to North Carolina. Florida and North Carolina have the largest acreage of SAV beds. Seagrasses form one of the most productive plant communities in the world, providing foraging grounds and shelter for fish, invertebrates, mammals, and birds (Thayer et al. 2003).
Shellfish Reefs	none	Shellfish reefs are widespread in estuarine and coastal bay systems along the U.S. Atlantic coast. Eastern Oyster (*Crassostrea virginica*) is the primary reef-building species, and can form reefs or bars that cover extensive areas in estuarine systems. Oyster reefs can be either subtidal or intertidal.
Nearshore Hard Bottom	*Hard/ complex bottoms*	Present throughout the Atlantic planning areas, nearshore hard-bottom habitats are areas of submerged solid, exposed substrate. They may contain attached algae, sponges, and corals. Often, hard-bottom sites support higher concentrations of marine life than surrounding areas. They contribute sand to the formation of beaches through both physical erosion and bio-erosion (Deaton et al. 2010).
	Coral Reefs	Coral reefs are highly diverse ecosystems, characterized by the presence of structure-building corals. The physical structure is composed of marine polyps that secrete a hard calcium carbonate skeleton. Nearshore reefs are present only in the Straits of Florida Planning Area.
Nearshore Soft Bottom	none	Subtidal, unconsolidated sediments that are widespread both generally and along the U.S. Atlantic coast. Benthic communities form the basis of the marine food web and play an important role in nutrient cycling. Both oceanic and estuarine soft-bottom habitats are important foraging grounds for fish and invertebrates.
Water Column	none	Estuarine and marine waters within the coastal zone. Physical properties of the water column vary based on the biological and physical forces within a region. Vertical stratification can occur due to differences in densities of water masses concomitant with a lack of mixing, and can affect the distribution of habitat with respect to temperature, salinity, dissolved oxygen, nutrients, and contaminants (SAFMC 2009).

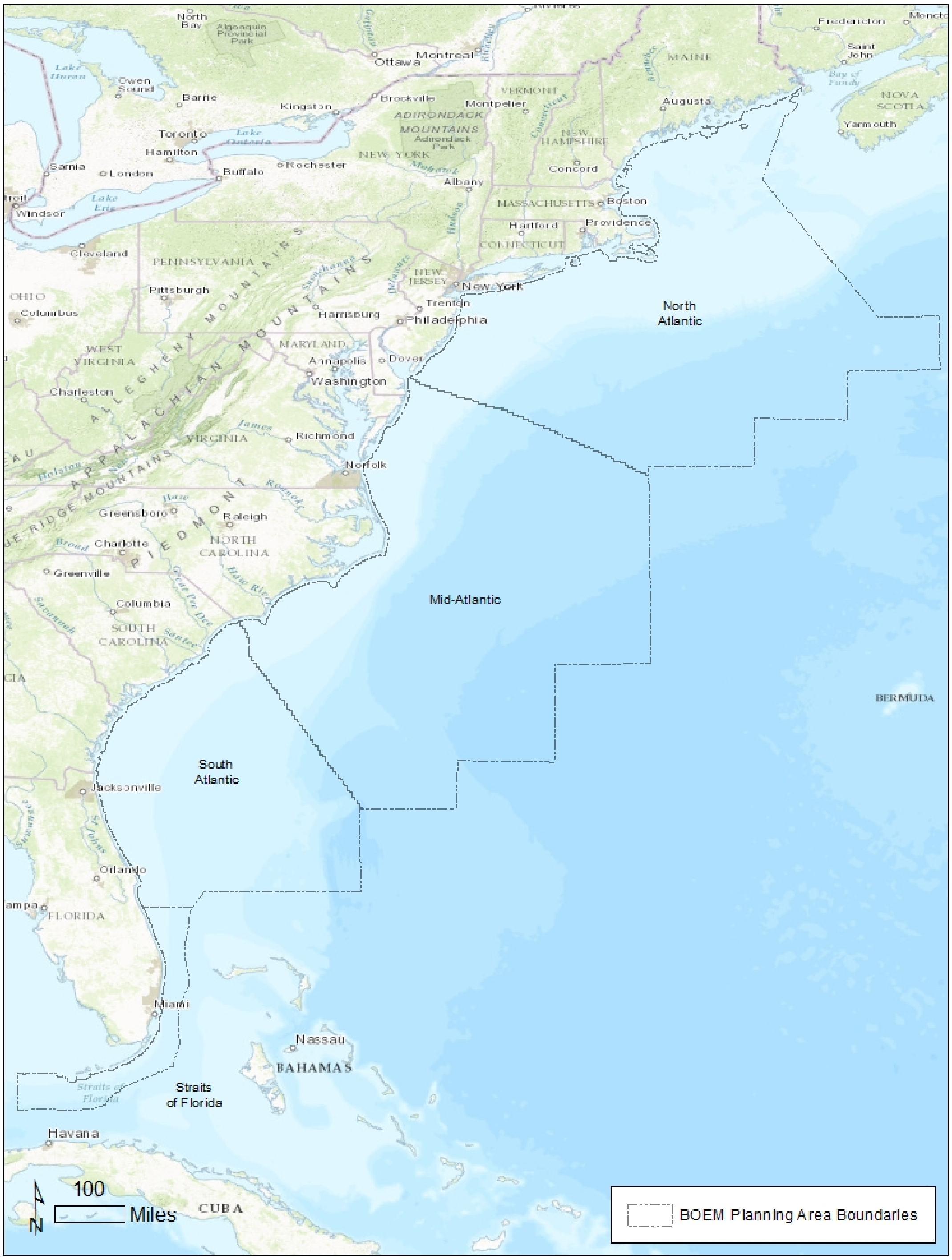


Figure 3-1. The geographic area of interest for the Atlantic BOEM Planning Area habitat descriptions.

3.1 Descriptions of Coastal Habitats

Coastal habitats are described here to provide affected environment conditions and context for potential impacts of COP activities on these habitats. Offshore wind energy facility construction and maintenance activities such as vessel anchoring and groundings, installation of infrastructure such as cables, increased vessel-induced wave action and erosion, and direct loss of habitat for land-based utilities can affect coastal habitats directly and indirectly. The major concerns of noise levels, increased vessel traffic, erosion, and contaminant release from sediments on benthic and pelagic habitats (Bailey et al. 2014) can also affect nearshore and coastal habitats. Land-based and landfall activities, rather than offshore activities, are most likely to have direct impacts on coastal habitats.

3.1.1 Coastal Uplands

Coastal uplands include coastal, or maritime, forests and strands that occur primarily on barrier islands of the U.S. Atlantic coast and landward of beaches and primary dunes (Figure 3-2). Along the U.S. Atlantic Coast, barrier islands occur along 78% of the coastline (Zinnert et al. 2016). Barrier system upland vegetation has received little attention despite rapid and extensive coastal development in these coastal systems (Feagin et al. 2010; Zinnert et al. 2016), indicating a need for baseline data to characterize these systems. Coastal scrubs occur along stabilized dunes on barrier islands and coasts from South Carolina to Florida. Coastal strand is an evergreen shrub community growing on stabilized coastal dunes parallel to the coast, often with a smooth canopy due to pruning by salt spray. It usually develops as a band between dunes dominated by sea oats (*Uniola paniculata*) along the immediate coast, and maritime hammock, scrub, or mangrove swamp communities farther inland. On broad barrier islands or prograding coasts, it may also occur as patches of shrubs within a coastal grassland matrix. Typical vegetation in temperate scrubs (also called coastal strands) includes saw palmetto (*Serenoa repens*), cabbage palm (*Sabal palmetto*), red bay (*Persea borbonia*), sea grape (*Coccoloba uvifera*), and live oak (*Quercus virginiana*)(FNAI 2010).

Maritime forests are low forests of evergreen, broadleaved trees found inland from coastal strand and dune communities on the U.S. Atlantic coast and occur as narrow bands of forest, predominantly on stabilized backdunes of barrier islands. Maritime forests occur discontinuously along the entire U.S. Atlantic coast, interrupted by inlets and bays as well as coastal development and agriculture (Smithsonian Institution 2016). These forests are characterized by a canopy of live oak and other plant species dwarfed by salt spray, which kills the upward-growing leader shoots. Adjacent maritime forests are often floristically similar to one another and show strong floristic affinity with nearby mainland forests. On a finer scale, subtle floristic differences have been noted with respect to the relative abundance of plant species in nearby forests or on adjacent islands. The cumulative effect of these subtle floristic changes becomes evident when the maritime forest flora of Cape Cod, Massachusetts, is compared with that of Cape Canaveral, Florida. The extreme locations are quite different floristically, although the shifts in species are transitional and without sharp discontinuities (Bellis 1995).

Coastal uplands are susceptible to COP activities associated with landfall and construction and maintenance of substations and transmission lines. These activities can cause habitat fragmentation, shifts in vegetation communities, and potential contamination in the event of a spill.

Figure 3-2. Cross section of Core banks, NC, an undeveloped barrier island. Multiple habitats are shown, including beach, dune, coastal upland, and salt marsh.

3.1.2 Dunes

Dunes are mounds of unconsolidated sandy soils that occur between coastal uplands and shorelines. They are differentiated from beaches by the presence of vegetative communities (VIMS 2009). Dunes are dynamic features that change in height and are reworked as wind moves sand along the beachfront and storm surges overwash the dune habitat. Dunes consist of a primary dune that is closest to the ocean, and a secondary dune that occurs landward of the primary dune (Figure 3-3).

Primary dunes are characterized by beach grasses (north of Cape Hatteras) and sea oats (south of Cape Hatteras) (USFWS 1999). These plants are early colonizers of dune habitats, and act to trap sand and accelerate dune formation. Primary dunes are nesting habitat for shorebirds during the spring and summer months (Delaware Sea Grant 2003). Secondary dune habitats occur behind the primary dune, and are more stable in nature and characterized by small plants and shrubs. Dunes are harsh environments for plant growth due to the effects of salt spray, strong winds, and sand blasting. Interdunal swales, which are low-lying areas within the secondary dune, may be present and support small areas of wetland vegetation. Secondary dunes also support populations of small mammals such as foxes and raccoons (Delaware Sea Grant 2003).

Dunes buffer the effects of storms along coastlines and provide a reservoir for beach sand. In addition, they are habitat for many species, including several species of threatened or rare rodents, snakes, and insects. Dunes also provide water quality services by filtering the rainwater (VIMS 2009). The primary anthropogenic threat to dunes is development, which results in loss of natural dune habitat and interruption of the natural sediment transport systems. Shoreline hardening interrupts the natural sediment transport dynamics of dunes and beaches, causing extreme erosion in some places. Between 1990 and 2000, beach and dune habitat from Virginia to Maine was lost at an estimated rate of 165 acres per year (Anderson et al. 2013). Development in southeast Florida has altered an estimated 90% of the coastline in Broward and Miami-Dade counties (Marshall and Banks 2013). Degradation of sand dunes also occurs as foot and vehicle traffic cause erosion through the dunes and trample native dune vegetation. Invasive species are also a concern in dune ecosystem (Barbier et al. 2011; Marshall and Banks 2013). Large tracts of intact dune habitat are more commonly found in protected areas and/or undeveloped barrier islands from south Florida (Marshall and Banks 2013) to southern Maine.

Effects of COP activities on dunes may include loss and/or disturbance of habitat, erosion and stormwater runoff, contaminant spills, and an increase in marine debris. Associated vehicle traffic can result in habitat destruction, temporary habitat loss, increased stormwater runoff, contaminant releases, and opportunities for expansion of invasive species.

Figure 3-3. Examples of sand beaches with low and high dune habitats.

3.1.3 Beaches

Beaches are shorelines consisting of unconsolidated sediments. Sand beaches are commonly found along the U.S. Atlantic coast. Large stretches of sandy beaches occur from southern Maine to south Florida, often as barrier islands. Barrier Islands are dynamic features that are constantly being reshaped by wind, ocean currents and storms. Beach sediments are constantly moving due to the influence of waves and wind. Because of this, the beach face changes seasonally as wind and wave exposure change (VIMS 2009). Storm events can move large amounts of sand offshore and create new features in a barrier island system. Seasonal climatic differences can cause the beach face to erode and accrete in a cyclical manner. Barrier beaches can front tidal lagoons, salt ponds or salt marshes. Beaches can be present along riverine, estuarine and marine shorelines.

Sand beaches are exposed, harsh environments that do not support many species, mainly isopods and amphipods. Exact species composition is determined by the grain size and wave regime experienced by the beach (Gustavson 2010). Common surf zone inhabitants are surf clams and mold crabs. The upper portions of sand beaches are nesting habitat for shorebirds and sea turtles, and the lower portions are foraging habitat for birds and fish.

Cobble and gravel beaches can be present north of Long Island Sound. They are often interspersed with rocky shorelines. Cobbles are mobile and roll around in the surf. As a result, not many species are able to survive in cobble beaches (Tyrell 2005).

Figure 3-4. Cobble beach (left) and piping plover chick on a mixed cobble/sand beach (right).

Sediments within beach and dune systems are constantly in flux. Construction of hardened shorelines and jetties interrupt the transport of sand along shore and between the beach and adjacent dunes (Pilkey and Wright 1988). As sand is lost from the system, beaches narrow and erosion events become more severe. Loss of habitat for species due to erosion and shoreline development can threaten populations of species dependent on these areas, such as horseshoe crabs, who use beaches to spawn (Tanacredi et al. 2009).

COP activities can affect beaches and dunes and result in loss and/or disturbance of habitat due to landfall activities, stormwater runoff and erosion, contaminant spills, increased vessel traffic and erosion, and an increase in marine debris.

3.1.4 Salt/Brackish Water Wetlands

The dominant salt and brackish wetlands present in the Atlantic planning region are salt marshes (Figure 3-5) and mangrove forests (Figure 3-6) The two wetland types are dominant within their respective ranges; mangroves south of Ponce de Leon Inlet, Florida and salt marshes throughout the rest of the Atlantic planning region. Marshes occur along low-energy shorelines and are susceptible to erosion from increased wave energy. Proximate COP activities may result in disturbance or permanent loss of these habitats, accidental contaminant spills, and stormwater runoff, and reduced water quality.


Figure 3-5. Aerial and ground view of salt marshes.

Salt marsh. Salt marshes are common estuarine habitats that are found in temperate and sub-tropical environments along the U.S. Atlantic coast, from Maine to Florida. They are characterized by halophytic, soft-stemmed emergent vegetation that is highly adapted to living in periodically or continually flooded soils. The composition of the plant community within salt and brackish marshes is highly influenced by slight differences in elevation, hence slope and elevation are defining aspects of these habitats. Low marshes generally occupy an area in the tidal prism from mean water level to mean high water, while high marshes can occupy elevations above the mean high water level, in locations where they are only occasionally flooded by tidal and storm inundation. *Spartina* spp. are the dominant salt marsh species in low intertidal zones and *Juncus* spp., dominant in upper intertidal areas. Other plant species can include spike grass (*Distichlis spicata*), salt marsh plantain (*Plantago maritima*) and saltwort (*Batis maritima*). Macroalgae and microalgae can be found growing on the lower portion of emergent vascular plants and the sediment surface, and is an important primary producer in salt and brackish marshes (Thayer et al. 2003).

Salt marshes are highly productive; however, few aquatic species consume the marsh grasses directly. Rather, decaying vegetation supports a detrital food chain. Smaller detritivores, such as marsh periwinkles and amphipods are aggregated by marsh vegetation, which provides them both food and shelter. These animals form the basis of a food chain that supports nursery habitat for many commercially and recreationally important fish and invertebrates, such as blue crab (*Callinectes sapidus*), white shrimp (*Litopenaeus setiferus*), northern brown shrimp (*Farfantepenaeus aztecus*), flounder species, spotted seatrout (*Cynoscion nebulosus*), and red drum (*Sciaenops ocellatus*) (Thayer et al. 2003). In addition, numerous transient species (aquatic, terrestrial, and avian) use salt and brackish marsh habitats as feeding and resting areas during seasonal migrations.

In addition to their function as wildlife habitat, salt and brackish water marshes perform other vital ecosystem functions like nutrient cycling, carbon sequestration, sediment stabilization, and wave attenuation. Coastal marshes also provide important ecosystem services to society, including flood control, storm surge protection, water filtration, pollution removal, and a diversity of recreational and commercial activities (Bertness 1999).

Coastal wetlands, including salt and brackish marshes, are some of the most heavily used and severely threatened natural systems worldwide (Worm et al. 2006; Halpern et al. 2008). Over the last hundred years they have been heavily exploited and significantly altered for coastal development, navigation, seafood production, flood control, agriculture use. For example, Rhode Island's marsh loss is estimated at 95% of historical levels (Bertness 1999). Stressors to salt marshes include clearing of vegetation or destruction of habitat, ditching/draining for agricultural use or mosquito control, hydrologic alteration, invasive plant and animal species, contamination, and shoreline hardening/erosion. Some of the most direct and destructive physical impacts on these ecosystems are associated with the construction of shoreline and coastal infrastructure like bulkheads, docks, piers, dikes and levees that modify the structure and function of the ecosystem (Kennish 2002). Physical disturbance, habitat loss, and increased erosion in salt marshes due to construction of transmission lines may add to the stressors already affecting salt marshes.

Mangrove forest. Estuarine and brackish wetlands in South Florida are primarily mangrove forests. In the continental U.S., mangrove forests are only found in peninsular Florida. Four species of mangrove occur in south Florida - red mangrove (*Rhizophora mangle*), black mangrove (*Avicennia germinans*), white mangrove (*Laguncularia racemosa*), and buttonwood (*Conocarpus erectus).* Of these, the red mangrove is the most conspicuous, distinguished by the prop roots that help stabilize the plant.

Figure 3-6. Examples of mangrove shorelines.

The complex structure of mangrove forests provides both aquatic and terrestrial habitat for at least 1,300 species of animals (USFWS 1999). The prop roots, trunks, and pneumatophores form a vegetative reef surface in the subtidal and intertidal zones, providing shelter and foraging areas for many species of fish and invertebrates. More than half of commercial and recreationally targeted fish and invertebrates rely upon mangrove forests for food and habitat at some point in their life cycle (Lewis et al. 1985). The canopy forms a multi-branched forest with a wide variety of surface habitats (Savage 1972), which are used for breeding, nesting, foraging, and shelter for over 191 species of bird, including neotropical migrants, overwintering shorebirds and ducks, rare passerines, raptors, and colonial waterbirds (Odum et al. 1982; Beever 1989; Day et al. 1989; Odum and McIvor 1990). Mangroves have a significant ecological role as habitat for endangered and threatened species, several of which only occur in mangrove habitats.

Mangroves are important to the nutrient mass balance of the estuarine ecosystem. They are one of the most productive ecosystems in the world (Day et al. 1989). Studies have found that red mangroves contribute 85% of the detrital food base in south Florida estuarine food webs (Lewis et al. 1985). In addition, mangroves alter the physical environment by trapping and stabilizing intertidal sediments, forming organic soils, and providing protection from both wind and wave erosion. Mangroves also improve water quality and clarity by filtering upland runoff and trapping waterborne sediments and debris.

Mangroves are threatened by primary and secondary effects of development, including loss of habitat, clearing, excessive sedimentation, changes in hydrology (i.e., ditching/draining), alteration of soil and water salinity, and invasive species (USFWS 1999). Mangroves were lost in large numbers between the 1950s and 1980s due to development. Currently they are protected, so ongoing losses are minimal. The primary driver of mangrove loss in the Florida Keys in the near future will be climate change, as sea levels rise at a level that exceeds sediment accretion and mangrove habitat is lost (Lorenz 2013).

3.1.5 Tidal Flats

Tidal flats are normally associated with inlets, estuaries or shallow bays and are classified as unconsolidated shores which can be composed of sandy and/or muddy sediments (Cowardin et al. 1979). Sand and mud flats (Figure 3-7) are primarily associated with tidally influenced marine environments, where tidal fluctuations lead to the exposure of large expanses of shore at extremely low tides and inundate the flats at high tides when the water level is at or just above the surface of the substrate. Sand flats are typically associated with higher energy environments where currents and wave action prevent the deposition of finer sediments. Mud flats occupy lower energy areas, usually located in the most sheltered areas of the coast where large quantities of silt from rivers are deposited, and contain organic materials of smaller grain sizes than sand (USEPA 1980). Unlike seagrass beds and marshes, tidal flats usually lack aquatic macrophytes but can contain vegetation in the form of micro- and macroalgaes. They can also be rich in diatoms, a major food source for many invertebrates and some fishes (Thayer et al. 2003).

Figure 3-7. Examples of sand (left) and mud (right) flat habitats.

Sand flats provide habitat for burrowing macro- and micro- invertebrates and, when covered by water, for small fishes. They also provide valuable feeding grounds for many transient and resident species of wading birds, shorebirds and predatory fish species that prey on infaunal species. Like sandy beach habitats, sand flats are usually dominated by, meio-, micro- and macrofauna, and act as a sink for small particles, detritus and nutrients (Thayer et al. 2003).

Mudflats also provide habitat for large numbers of macroinvertebrates, like polychaete worms and bivalves, and are vital feeding grounds for members of the higher trophic levels, especially the transient species that move into the flats with the high tides. These transient species can include detritivorous and planktivorous organisms, as well as predatory species of birds (e.g., sandpipers, oystercatchers, and plovers) and fish. During low tide, shorebirds use the exposed flats for feeding grounds, while wading birds look for prey that become stranded in tidal pools (Bertness 1999).

In addition to functioning as habitat, tidal flats can also act as buffer systems that modify, or attenuate, wave energy and reduce shoreline erosion (NCDEQ 2016). Furthermore, flats sequester carbon as organic sediments settle onto the flat and are rapidly buried (Savarese 2013). Tidal flats are essentially intertidal soft bottom, so many of the functions and threats described in that section also apply to tidal flats.

Threats to tidal flats include alteration in sedimentation rates and nutrient flows' hydrologic alteration, such as dredging; and contamination, as surface runoff is sequestered into the sediments (Savarese 2013). Construction of transmission lines may damage these habitats directly and kill associated organisms. Increased wave action could alter sediment transport patterns.

3.1.6 Rocky Intertidal Zone

Along the U.S. Atlantic coast, rocky shorelines are primarily found north of Cape Cod, where glaciers scoured the coast of sediment during recent Ice Age. Rocky intertidal habitats are characterized by sharp environmental gradients, ranging from the low rocky intertidal zone to upper intertidal zone. Rocky shores can be characterized by three distinct zones: (1) the supralittoral zone, or splash zone, (2) the eulittoral zone, which occurs between the low and high tide lines, and (3) the sublittoral zone, which remains submerged (Little and Kitching 1996). Rocky intertidal habitats provide substrate for algae, seaweed and kelp species to attach. Sessile plants and invertebrates provide a source of food and shelter to mobile organisms that live in the tidal zone (Barnes and Hughes 1988). Rocky shores provide important ecosystem functions where they exist such as biomass export, wave energy attenuation, invertebrate habitat, and feeding grounds for mammals and birds (Thayer et al. 2003). They also provide vital spawning and nursery habitat for some nearshore fish species.

Figure 3-8. Examples of sheltered and exposed rocky shorelines in the North Atlantic Planning Area.

In rocky intertidal habitats, biological forces (i.e., predation and grazing) and the physical environment are important in controlling the density and zonation of plants and sessile species (Menge 1983). Sessile species occupy habitat niches that are determined by their physiological tolerance of the organisms to local environmental conditions, and competitive interactions with other organisms (Connell 1972). Common plants found on rocky shores are red algae, green algae, and brown algae (Little and Kitching 1996). Sessile, filter feeding organisms such as barnacles, chitons, anemones and bivalves are also commonly found in these habitats (Barnes and Hughes 1988). Mobile animals also are common in rocky intertidal regions including crabs, sea urchins and gastropods (Taylor and Littler 1982). Many species of fish (e.g., striped bass, sculpins, blennies and toadfish) and birds (e.g., sea ducks, wading birds, shorebirds and seagulls) are also regularly found among rocky intertidal habitats, while some marine mammals, including seals, also use rocky shorelines for feeding, breeding, and resting areas (Thayer et al. 2003).

Rocky intertidal habitats are threatened by invasive species, contamination from runoff and other marine pollution, direct disturbance of sensitive habitats, and other water quality impairments (Bertness 1999). Impacts on rocky intertidal habitats from COP activities associated with OSW facilities are likely to include disturbance of attached vegetation communities during construction and maintenance and impacts of increased wave energy.

3.1.7 Submerged Aquatic Vegetation (SAV)

SAV habitat is composed of marine, estuarine and riverine rooted, vascular plants. SAV communities can be separated into high salinity (18–30 practical salinity units [psu]), brackish (5–18 psu), and freshwater (0–5 psu) communities. Of these, freshwater SAV communities have the highest species diversity (NCDEQ 2016).

SAV species have horizontal underground stems called rhizomes that erect shoots that bear the leaves and leaf sheaths. Roots also branch off of the rhizomes and absorb nutrients and help anchor the plants in the substrate (Thayer et al. 1984; Larkham et al. 1989). This complex rhizome and root structure also provides an elaborate habitat for infaunal invertebrates (Zieman 1982; Thayer et al. 1984). Some animals consume SAV directly, including manatees, sea turtles, crustaceans and some waterfowl species. However, seagrass beds generally support a detrital food chain, in which decomposing seagrasses release nutrients that support plankton, meiofauna and flora, benthic flora and fauna, and microbes (Mateo et al. 2006). In addition, epiphytic microalgae that grows abundantly on the blades of seagrass increase the productivity of these habitats. The combination of plants that make up seagrass meadows depend largely on environmental factors, like water depth and water quality. North of North Carolina, eelgrass (*Zostera marina*) is the dominant seagrass. South of South Carolina, turtle grass (*Thalassia testitudinalis*) and shoalgrass (*Halodule wrightii*) are the dominant seagrass species (Bertness 1999). SAV beds require significant protection from wind and waves, and therefore occur in sheltered locations (Mitsch and Gosselink 2000).

SAV beds form one of the most productive plant communities in the world. They function as spawning and nursery habitats for numerous fish and invertebrates species, and also provide feeding grounds for both resident and transient fish, invertebrate, mammal, and bird species (Zieman 1982; Thayer et al. 1984; Orth et al. 1984; Day et al. 1989; Heck et al. 1989; Mattila et al. 1999). In addition to their productivity, SAV species are important ecosystem engineers, trapping and stabilizing sediments, provide wave attenuation, and nutrient cycling benefits (NCDEQ 2016).

SAV beds may be subject to frequent and infrequent natural disturbance processes, such as bioturbation, overgrazing, scouring, and disease-associated perturbations, as well as anthropogenic impacts. The loss of seagrass habitats, regardless of the cause, is very difficult to reverse. Water clarity is one of the most critical factors necessary for the maintenance of healthy SAV habitats; without adequate light penetration, photosynthesis is impeded, and seagrass will die. Eutrophication (i.e., nutrient enhancement) and increased sedimentation can also affect water clarity, and therefore affect the health of SAV, and are thought to be a primary cause in the loss of seagrass beds in Chesapeake Bay (Bertness 1999). Eutrophication, or enhancement of nutrient levels in the water, may also enhance the nutrient base for algal species, which may eventually outcompete seagrasses (Short and Wyllie-Echeverria 1996). Physical threats to SAV include direct impacts from vessel groundings, fishing gear interactions, or coastal construction, such as installation of structures and HDD or dredging, which may bury or remove seagrass (Short and Wyllie-Echeverria 1996). Activities related to offshore wind development may cause habitat destruction, increased sedimentation, and the potential for increased contamination.

3.1.8 Shellfish Reefs

Shellfish reefs are widespread in estuarine and coastal bay systems along the U.S. Atlantic coast of the United States. On the eastern seaboard, the Eastern Oyster (*Crassostrea virginica*) is the primary reef-building species, and can form reefs or bars that cover extensive areas of bottom in estuarine areas. Oyster reefs can be either subtidal or intertidal (Figure 3-9).

Figure 3-9. Oyster reef with oystercatchers (left) and SAV bed (right).

Oyster reefs can occur across many acres of bay bottom in intertidal and subtidal areas, and are commonly found oriented perpendicular to tidal flow, in parallel crescent-shaped bars. These formations allow maximum exposure to tidal currents, which prevent sedimentation on reef and provide live oysters with access to phytoplankton in the water column. Oyster reefs are also dependent on the import of detrital and planktonic food resources from adjacent habitats, including emergent marshes and open-bay waters (Shipley and Kiesling 1994). Oysters filter large amounts of water, which can greatly improve water quality around the reefs and within the embayments they occupy.

Shellfish reefs are very productive environments that provide shelter, structure and food for many marine organisms including crab, shrimp, fish and other shellfish species. The numerous invertebrate and fish species that utilize oyster reefs during their lifecycles implies trophic transfers between adjacent marine and estuarine habitats as species travel to and from reefs with the tidal cycle. Intertidal oyster reefs can be utilized by birds. Certain plant species can also occupy this habitat, including crustal algae, which attaches to shell substrates supporting a small grazing food chain (NCDEQ 2016). Oyster reefs are estimated to have high secondary and tertiary productivity, indicating their importance to larger fish and invertebrate species (English 2009). Intertidal shellfish reefs also help protect shorelines from erosion by attenuating wave and tidal energy, and can cause accretion in adjacent salt marshes (Meyer et al. 1997).

Oyster reefs are susceptible to changes in water quality and physical disturbance and can be adversely affected by increased sedimentation, loss and/or disturbance of habitat due to vessel interactions and dredging, contaminant spills, and introduction of invasive species. Increases in vessel activity may also cause longer-term impacts in the form of increased sedimentation.

3.1.9 Nearshore Hard Bottom

Hard-bottom habitats (Figure 3-10) are defined as exposed areas of rocks and include hard substrates in the nearshore environment that may be affected by disturbance in the coastal ocean. These areas provide physical relief that is used by fish for protection, and can provide a substrate for sessile invertebrate communities. For the purpose of this assessment, coral reefs are considered a type of hard-bottom habitat.

Hard/Complex Bottoms. Hard-bottom contributes sand to beaches through both physical erosion and bioerosion (Deaton et al. 2010) and provides attachment surfaces for sessile invertebrates and algae. The productivity created and/or aggregated on hard-bottom communities provides food for fishes and invertebrates and the benthic complexity provides shelter; therefore, these areas are much more biologically diverse than the surrounding waters (SAFMC 2009). Hard-bottom habitat is also spawning and nursery habitat for some species of fish (Deaton et al. 2010). Live bottom fauna such as sea whips and soft corals may take years to recover from physical disturbances of hard-bottom habitats.

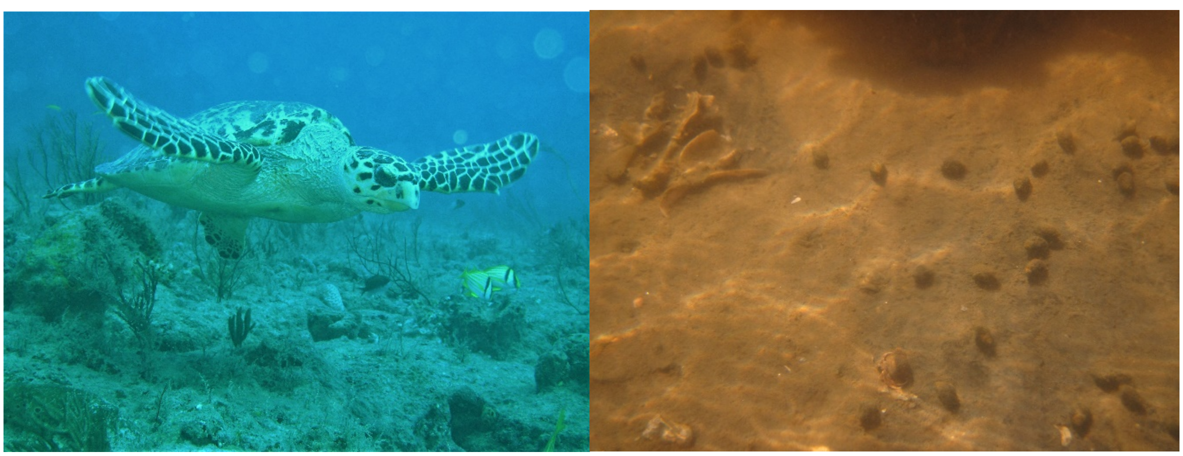


Figure 3-10. Loggerhead sea turtle over hard-bottom habitat (left); representative shallow soft-bottom habitat (right).

Coral Reefs. Coral reefs are highly diverse ecosystems, composed of marine polyps that secrete a hard calcium carbonate skeleton. Corals have a symbiotic relationship with photosynthetic algae, where in the algae live inside the coral polyp and provides food for the coral (Rowan and Powers 1991). These colonies continue to build new corals, adding to the size of the reef. The structure provided by coral reefs provides shelter and food for many marine fishes and invertebrates. In addition, some species of reef fish aggregate near coral reefs (Domeier and Colin 1997).

Coral reefs are negatively affected by many aspects of coastal development. Observed decreases in coral coverage and increases in disease indicate that reef health is declining in southeastern Florida and the Keys (Turgeon et al. 2002). Monitoring stations have revealed as 44% decline in coral cover between 1996 and 2005 (FDEP 2015). Impacts on coral reefs include increases in sedimentation and turbidity due to declines in water quality, physical disturbance, which kills attached sessile invertebrates, and damages the habitat structure; and water pollution issues, which may negatively affect corals themselves and associated communities (FDEP 2015). Climate change may also negatively affect coral reefs, because corals are stressed by increasing temperatures and ocean acidification.

Both coral reefs and hard-bottom habitats are susceptible to habitat destruction and/or burial during construction of transmission lines and/or potential contamination due to spills during construction and/or dredging/resuspension of contaminated sediments disturbed during COP activities associated with OSW development.

3.1.10 Nearshore Soft Bottom

Soft-bottom habitats are characterized by the mobility of unconsolidated sediment (Peterson and Peterson 1979), and are composed of loose fine to coarse-grained sediments. Here we consider soft bottom to be nearshore subtidal habitats; intertidal soft bottom is considered in the “tidal flats” section. Soft substrates support diverse assemblages of infaunal communities and algae that form the base of the food web. These organisms can be categorized as infauna (living in the substrate), epifauna (living on top of the substrate) and demersal (mobile organisms using the bottom). While soft bottom is less productive than other estuarine environments (i.e., seagrass beds and shellfish reefs), it often is the dominant habitat type, and may contribute more to total productivity than other submerged habitats (NCDEQ 2016). Due to their role in nutrient cycling, benthic invertebrates are among the most important components of coastal ecosystems.

Soft-bottom habitats are important foraging areas for many fish, invertebrates, and birds. Benthic microalgae (e.g., diatoms, dinoflagellates, blue green algae) live on the surface of soft-bottom sediments, forming the base of the food web (Mallin et al. 2005). Both oceanic and estuarine soft-bottom habitats are important foraging grounds for fish and invertebrates. Reef species have been known to forage over adjacent soft-bottom habitats during the day (Lindquist et al. 1994). Surf zone habitats are devoid of benthic microalgal communities. Instead, localized phytoplankton blooms occur as a result of wave action (Hackney et al. 1996; McLachlan et al. 1981). Compared to estuarine soft-bottom habitats, surf zone habitats have relatively few macrofaunal species (Hackney et al. 1996), but they still provide the forage base for surf zone communities.

The physical environment provided by shallow soft-bottom habitats is important to fish and invertebrates. Shallow nearshore areas can be refuges for smaller animal species by excluding larger predators. In addition, some fishes and invertebrates (i.e., blue crabs, flounders) burrow into the sediment to avoid predation (Luettich et al. 1999; Peterson and Peterson 1979). Soft-bottom areas can also be used as movement corridors for some species of anadromous fish (e.g., sturgeon and striped bass) during their upstream migrations.

Benthic macroalgal productivity is relatively comparable among states in the Mid-Atlantic Planning Area, though there is some variation depending on the substrate and the light penetration (NCDEQ 2016). Soft-bottom habitats are important foraging grounds for both shortnose and Atlantic sturgeon in the South Atlantic, Mid-Atlantic and North Atlantic Planning Areas. Mobile epifauna common to estuarine soft-bottom habitats include blue crabs, horseshoe crabs, whelks, tulip snails, moon snails, penaeid shrimp, sand dollars and spider crabs (NCDEQ 2016). Shark nursery areas can be found in shallow soft-bottom areas in estuaries and the nearshore areas in the Mid-Atlantic, South Atlantic, and Florida Straits (McCandless et al. 2007)

Soft-bottom habitats have the potential to store and/or move nutrients throughout a system, depending on the environment. Benthic organisms link primary production with higher trophic levels, and also play a role in breaking down organic material. The magnitude of these benefits varies based on the hydrology and geomorphology of an area. Large, slow moving estuaries, such as the Albemarle-Pamlico Estuarine System, can act as nutrient sinks, nutrients, organic matter and phytoplankton production (NCDEQ 2016).

Soft-bottom habitats are relatively resistant to anthropogenic impacts as a result of their already dynamic conditions. Surf zone habitats in particular are commonly disturbed, and therefore comprise organisms that tend to recover rapidly (Posey and Alphin 2001, 2002). Soft-bottom sediments can accumulate contaminants, both organic and inorganic, which affect the benthic community. Hyland et al. (2004) demonstrated an inverse relationship between contamination and biotic integrity in North Carolina. Sedimentation can decrease water clarity, reducing available light for photosynthetic algal species that live on soft bottom. Impacts on nearshore soft bottom from offshore wind development may include resuspension of sediments, potential contamination, and physical disturbance due to construction activities.

3.1.11 Water Column

Water is the medium that connects coastal habitats. Nearshore water column habitats are far from homogenous with respect to physical characteristics (temperature, dissolved oxygen, nutrients) that many organisms rely upon. The coastal water column is made up of the rivers, estuaries and oceanic waters within the coastal ecosystem. Vertical stratification can occur due to differences in densities of water masses concomitant with a lack of mixing, and can affect the distribution of habitat with respect to temperature, salinity, dissolved oxygen, nutrients and contaminants (SAFMC 2009).

Riverine waters exhibit seasonal variations in flow based on rainfall patterns within the watershed. In temperate systems, flows peak in the spring, and decline until the fall, when the leaves fall from the trees and precipitation increases. Estuarine waters are mixing zones between salt and fresh water. Flood tides contribute coarse sediments, migrating organisms. Fine sediments, freshwaters, nutrients, and organic matter arrive in the estuary with ebb tides from upstream environs. Estuarine circulation is dependent on tides and the volume of freshwater input. Differences in these factors lead to varying residence times for estuaries across the U.S. Atlantic Coast Planning Area. Marine waters are influenced primarily by tidal flux. Circulation patterns are influenced by proximity to input, freshwater input, prevailing winds, currents, and shoals. Temperature and salinity are often uniform during cooler months, and may be stratified under warmer conditions (Menzel 1993).

Many fish and inverts broadcast planktonic or semi-demersal eggs into the water column, the timing of which has evolved to maximize the physiochemical properties of the water column necessary for development. The water column can also be a source of productivity by hosting phytoplankton populations. This distribution of phytoplankton is dependent on the nutrient inputs to an area.

Threats to water column habitat include increased sedimentation, which can affect the available light in an area, contamination due to accidental spills, and increased sediment and nutrient loads from stormwater runoff. COP activities associated with OSW development may temporarily reduce the amount of, or access to, water column habitat due to physical disturbance and/or water quality degradation. Activities related to offshore wind development may affect the water column by increasing vessel traffic and noise, increasing sedimentation, and potentially increasing contamination from construction activities.

3.2 Environmental Characterizations of Atlantic BOEM Planning Areas

The BOEM planning areas along the U.S. Atlantic coast include the North Atlantic, Mid-Atlantic, South Atlantic, and Straits of Florida Planning Areas and reflect gradual changes from temperate to sub-tropical environmental conditions. The seaward extent is defined by the state waters (3 nautical miles in most states and 9 nautical miles in Florida) of the U.S. Atlantic coastal states and the landward extent includes marine and estuarine coastal habitats adjacent to these shorelines in addition upland habitats that they abut. Only Atlantic waters are considered in the Straits of Florida Planning Area, defined as waters south and/or east of U.S. Highway 1 in the Florida Keys. The inland extent of coastal habitats along the eastern U.S. reflect both regional and site-specific differences in tidal influence and geomorphology. Consequently, the habitats described for each planning area shift from, for example, extensive saltwater and freshwater tidal marshes associated with large tidal rivers along the South Atlantic and Mid-Atlantic Planning areas to much smaller areas of salt marsh in the North Atlantic Planning Area.

3.2.1 North Atlantic Planning Area

The North Atlantic Planning Area (Figure 3-11) has a diverse range of regional variation in upland communities, from glacier-cut coasts that have shaped the coastlines from northern Maine to New York to large bays and coastal marshes present from Delaware to Cape Cod. Maine coastal uplands are defined by spruce-fir maritime forests and rose maritime shrublands. The northeastern coastal zone, which includes most of the coastal areas from Maine to New York, comprises oak-pine communities found in northern parts of the Mid-Atlantic Planning Area (Sohl 2002; Auch 2002). The U.S. Atlantic Coastal Pine Barrens, which historically covered most of New Jersey's upland areas near the U.S. Atlantic coast, Long Island, and Cape Cod, are named after the pitch pine and oak forests that occur farther from the coast. However, toward the coast there are relatively rare dune woodlands of holly, cherry, pitch pine, and other hardwood species as well as the nation's only maritime dune grasslands (Griffith 2010; Sohl 2002). Although development pressure has remained low throughout coastal Maine, relatively milder climates and gentler slopes south of Maine host the megalopolis of urban development that is centered around major U.S. cities, including New York City, NY; Philadelphia, PA; Newark, NJ; Boston, MA; and New Haven, CT (Sohl 2002).

The extent of salt marshes in the North Atlantic Planning area is small compared to the south and mid-U.S. Atlantic coasts. Often they are limited to narrow fringing marshes. The typical salt marsh profile in this planning area features a low-elevation, regularly flooded marsh typically dominated by salt marsh cordgrass (*Spartina alterniflora*). Higher-elevation, irregularly flooded marshes are composed of a mosaic of herbaceous plants, including marsh hay (*Spartina patens*), spike grass (*Distichlis spicata*), and black rush (*Juncus gerardi*) (Donnelly and Bertness 2001), while brackish areas, which can occur along upper edges of salt marshes and along tidal rivers, are characterized by salt marsh cordgrass (*Spartina alterniflora*), giant cordgrass (*Spartina cynosuroides*) and bulrush (*Scirpus* species*)* (Anderson et al. 2013). Low hypersaline salt flats, also known as pannes, present in this region are characterized by saltwort (*Salicornia* spp.) (Anderson et al. 2013). In the heavily populated of this region, most of the coastal wetlands have already been altered and marshes are only present as scattered enclaves of coastal wetland ecosystems (Gornitz et al. 2001).

Tidal flats are common in New England, north of Cape Cod, where the tidal amplitude is high (Whitlatch 1982), composing almost half of the intertidal habitats of Maine (Fefer and Schettig

1980). Where estuaries and river deltas are present in the southern portion of the North Atlantic Planning Area, tidal flats are commonly found bordering salt- and brackish-water marshes.

Beaches in the northern reaches of the planning area are often small pocket beaches that may range in sediment size from fine-grained sand to cobble/gravel. South of New England, the shoreline is characterized by fine- to medium-grained sand sediments that occur in long stretches along the interface between land and the Atlantic Ocean and are typically associated with barrier islands. North of Cape Cod, the shoreline comprises the remnants of glacial bays, which have formed rocky headlands. These areas are defined by rocky intertidal habitats, which are widespread in Maine, New Hampshire and south to Massachusetts Bay, but decrease in their presence south of Cape Cod, MA.

The coastal ocean areas in the North Atlantic Planning Area are nutrient rich and have supported the abundant commercial fisheries for centuries. Nearshore marine waters in New England are influenced by relatively low salinity waters from the north, off of the Scotian shelf (Parker 2012). South of Cape Cod, the continental shelf widens. Floral and faunal variation in the North Atlantic Planning Area follow the same geographical patterns as other habitats, with kelp beds being associated with rocky, shallower waters and eelgrass beds more common in lower energy estuarine systems. Where present, hard-bottom habitats in New England consist of boulder and ledge habitats in the nearshore environment. Hard-bottom communities are scattered across the continental shelf of the mid-Atlantic bight, and may be colonized by red algae, sponges, anemones, hydroids, northern stone coral, soft coral and sea whips. Hard-bottom habitats, characterized as “rock reefs,” are numerous in the nearshore areas from Rhode Island to Maine (Greene et al. 2010). Soft-bottom habitats are common throughout the region. Nearshore areas adjacent to the Gulf of Maine tend to have finer sediments and a higher diversity of seabed forms than further south in the North Atlantic Planning Area (Greene et al. 2010). Large expanses of shellfish reefs are not as common in the North Atlantic as in the Mid- and South Atlantic though shellfish reefs do occur throughout the area.

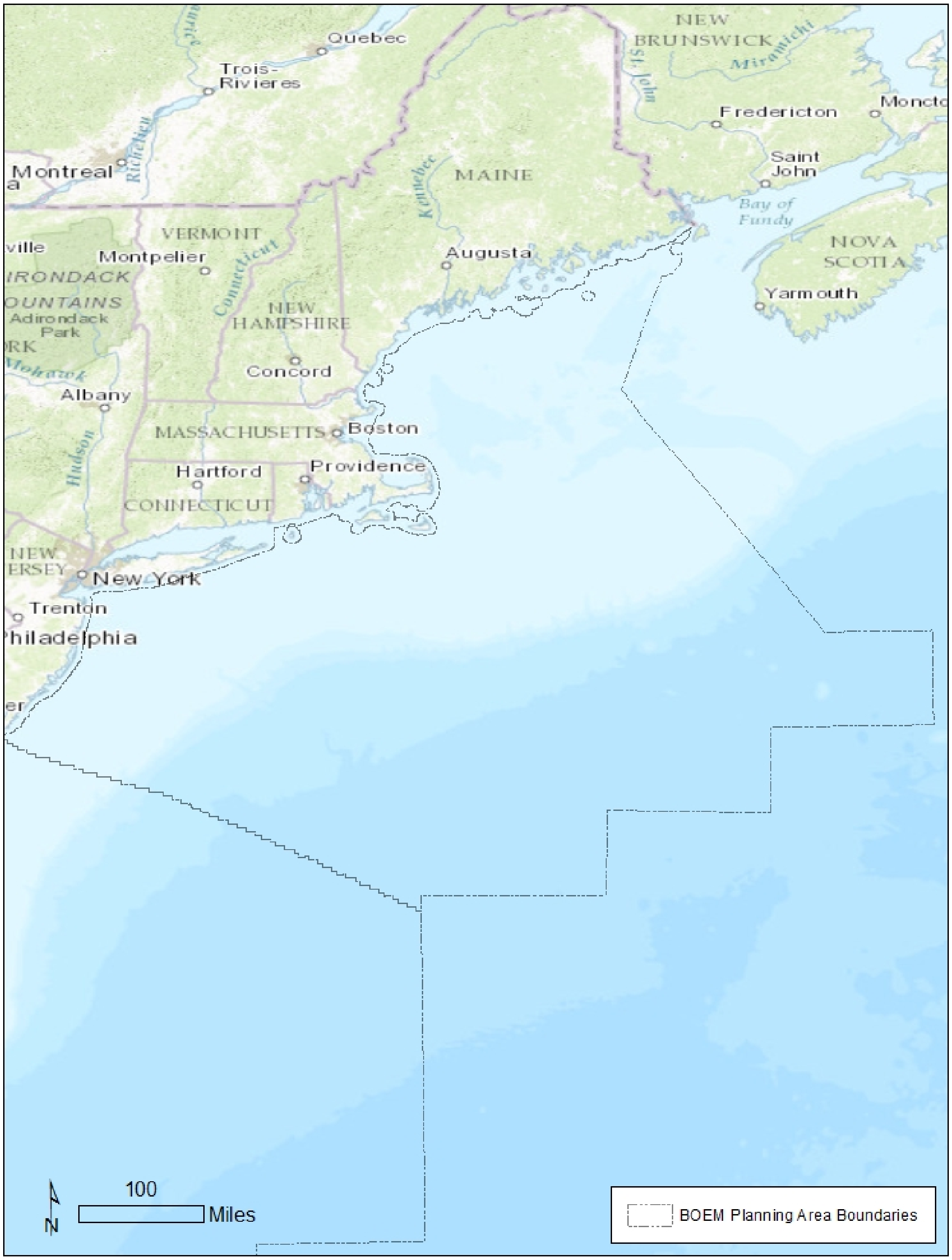


Figure 3-11. Area of interest for describing coastal habitats associated with the North Atlantic Planning Area.

3.2.2 Mid-Atlantic Planning Area

The Mid-Atlantic Planning Area (shown in Figure 3-12) coastal plain historically included a range of forested pine and deciduous pine mixed hardwood forests interspersed with freshwater swamps and tidal marshes. Its relatively flat topography and place in early European colonization have led to a present day landscape of managed forest, agriculture, and the remaining wetland complexes (Auch 2002; Griffith 2010). At the southernmost end of the planning region, south of Cape Hatteras, the deciduous coastal forests transition to the maritime evergreen forests that are described within the South Atlantic Planning Area section below (Auch 2002). It is also within this region of North Carolina that dune plant communities characterized by beach grasses north of Cape Hatteras transition to sea oat dominated communities that typify the South Atlantic Planning Area dunes (USFWS 1999). Overwash flats among the dunes provide important habitat for at least four federally listed species: northeastern beach tiger beetle (*Cicindela dorsalis dorsalis*), sea-beach amaranth (*Amaranthus pumilus*), and the piping plover (*Charadrius melodus melodus*) (Fleming 2001).

Salt- and brackish-water marshes and tidal flats are also defining habitats of the mid-U.S. Atlantic coastal landscape, especially in association with the large estuarine and coastal bay systems (e.g., Chesapeake Bay and Delaware Bay) and the numerous tributaries systems connected to them. However, Pamlico and Currituck Sounds, which have only minimal influence from lunar tides, are devoid of the large flats present in Chesapeake Bay and Delaware Bay, with small flats only present in some areas immediately adjacent to inlets (Peterson and Peterson 1979). Wetlands throughout this area have experienced changes to streamflow resulting from upriver impoundments and dams, and construction of agricultural irrigation and tidal dikes and levees to support lowland crops, such as rice, that require frequent inundation (Doyle et al. 2007).

SAV beds extend throughout the Mid-Atlantic Planning Area. Requiring waters with relatively low turbidity, large beds of SAV within the Mid-Atlantic Planning Area occur on the Outer Banks shoreline of Pamlico Sound with smaller beds (largely eelgrass) also present in the coastal bays of Maryland and Virginia. The co-occurrence of eelgrass, widgeon grass, and shoal grass is unique to North Carolina waters, which have the second largest estimated area of SAV beds (150,000 acres) among the Atlantic states, after Florida (NCDEQ 2016). Intertidal and subtidal oyster reefs are common in the Mid-Atlantic Planning Area, especially in the large estuaries, which include Chesapeake and Delaware Bays, and can grow to be quite large. Historically, oysters in the Chesapeake Bay grew large enough to become a navigational hazard (NOAA 2016a), and in certain coastal regions and in North Carolina, oyster mounds in Pamlico Sound may measure several meters in height (Lenihan and Peterson 1998). Oyster reefs are also found in the shallow coastal bays found along the Maryland and Virginia coast.

Hard-bottom habitat is scattered throughout the nearshore environment in the Mid-Atlantic Bight, but becomes more common south of Cape Hatteras (Deaton et al. 2010). Macroalgae are the dominant colonizing organisms on North Carolina hard bottoms, ranging from 10% to 70% of the biotic cover (Peckol and Searles 1984). These habitats may be found in the nearshore environment. Mid-Atlantic bight hard-bottom communities may be colonized by red algae, sponges, anemones, hydroids, northern stone coral, soft coral and sea whips. Soft bottom covers approximately 1.9 million acres, or 90% of estuaries and coastal rivers in North Carolina (Riggs 2001). Estuarine soft bottom supports over 400 species in North Carolina (Hackney et al. 1996; Hyland et al. 2004), including commercially important shrimp and blue crabs. Soft-bottom habitats are important foraging and migratory habitat for the both shortnose and Atlantic sturgeon, both of which are listed under the ESA. In North Carolina, large shoals exist in the ocean and extend across the shelf from each cape (NCDEQ 2016).

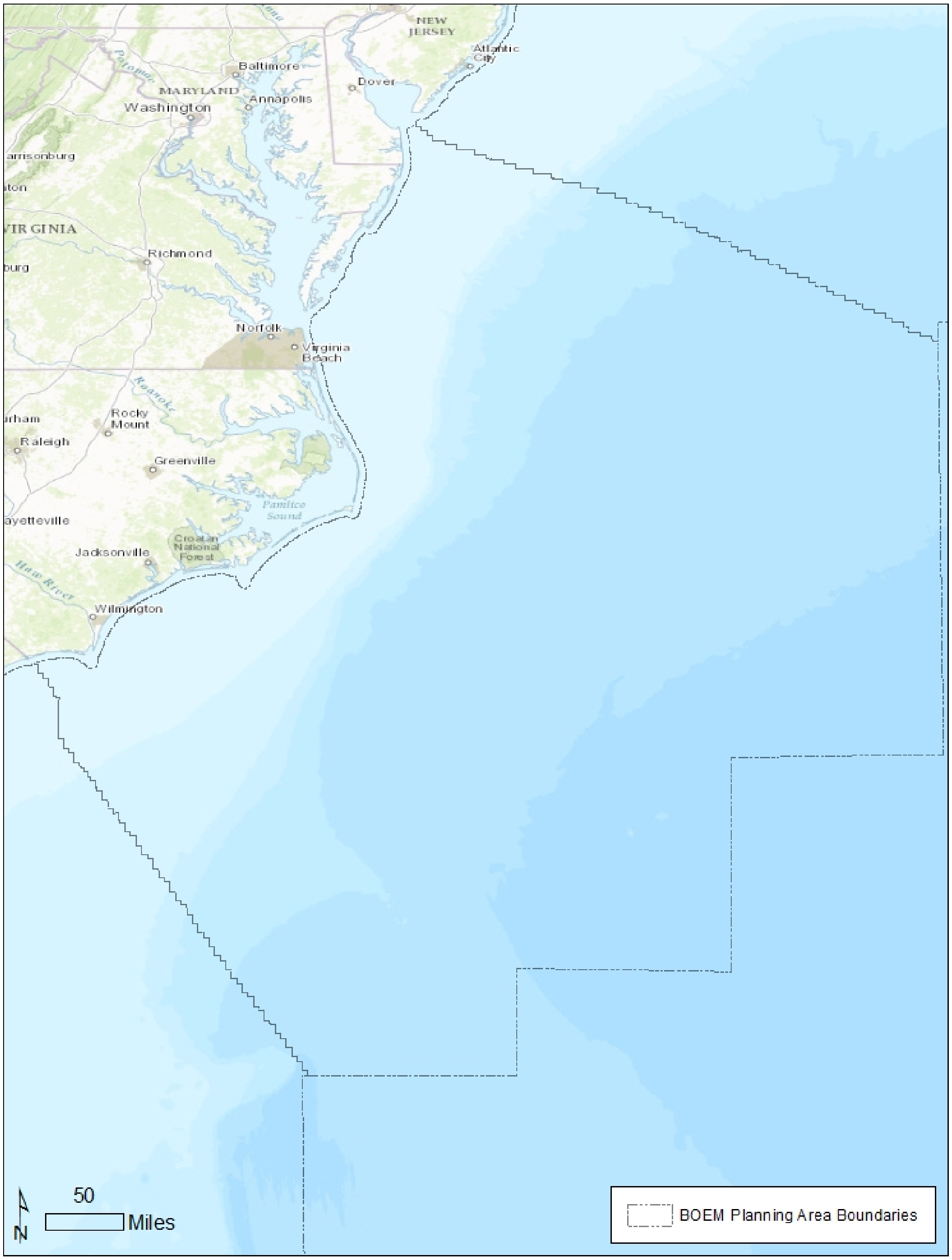


Figure 3-12. Area of interest for describing coastal habitats associated with the Mid-Atlantic Planning Area.

3.2.3 South Atlantic Planning Area

Along the coastal edge of the South Atlantic Planning Area (Figure 3-13), the South U.S. Atlantic Coastal Plain uplands were historically dominated by evergreen maritime shrublands and forest (TNC 2002). Maritime shrublands are distinctive ecotone between the high saltmarsh and the maritime forests. They are characterized by small woody evergreen species that include red cedar (*Juniperus virginiana*), yaupon holly (*Ilex vomitoria*), and wax myrtle (*Myrica cerifera*), among others (Bellis 1995). Evergreen maritime forests occur across the marginal sandy soils of barrier islands and old dune ridges on the mainland. As a result, they have relatively low diversity compared to the wetland forests in the region, and are predominantly composed of live oak (*Quercus virginiana*), laurel oak (*Q. hemisphaerica*), and loblolly pines (*Pinus taeda*) (Bellis 1995). Dunes throughout the South Atlantic Planning Area are dominated by sea oats; a more complex mix of ecotones and communities may be present along the back dune (USFWS 1999). Beaches are also similar to those found elsewhere along the U.S. Atlantic coast, although within the planning area, beaches in Georgia and South Carolina tend to be lower energy beaches relative to those in north Florida.

The coastal region of South Carolina and Georgia contain large expanses of coastal marsh (Duberstein et al. 2014; Odum et al. 1984); in fact, Georgia and South Carolina have the largest acreages of salt marsh area along the east coast (Bertness 1999). Sediment deposition from large river systems also leads to the formation of mudflats and intertidal oyster reefs in between the mainland and back barrier islands and expansive sand flats along the ocean-facing northern end of barrier islands. Wetlands within this area have experienced changes to streamflow resulting from upriver impoundments and dams, withdrawals for agricultural irrigation, and construction of tidal dikes and levees to support lowland crops, such as rice, that require frequent inundation (Doyle et al. 2007).

Nearshore marine waters in the South Atlantic are influenced by freshwater input, and generally flow from north to south (SAFMC 2009). Waters in the South Atlantic Planning Area can generally be divided into two distinct zones. North of Jacksonville, larger river systems are present, and estuarine waters are extensive. Where these estuaries transition into the ocean, they form the extensive salt marsh habitats described above. South of Jacksonville, watersheds are small and conditions are similar to the Straits of Florida. The large, sediment rich estuarine systems of the region create conditions too turbid to support SAV growth throughout most of the area; the only documented SAV beds appear in the planning area's most southern extent along Mosquito Lagoon and Banana River (SAFMC 2012).

Hard-bottom habitats occur throughout the South Atlantic Planning Area (Deaton et al. 2010). These ledges and reefs consist of outcroppings that rise 3 to 10 feet above the surrounding sandy substratum, and are colonized by corals, sponges, and other diverse fauna. Wenner et al. (1984) reported that sponges, bryozoans, corals, and anemones dominated the large macroinvertebrate community in terms of numbers and species diversity during all seasons at hard-bottom sites in South Carolina and Georgia. Soft-bottom habitats are common in estuarine and marine environments.

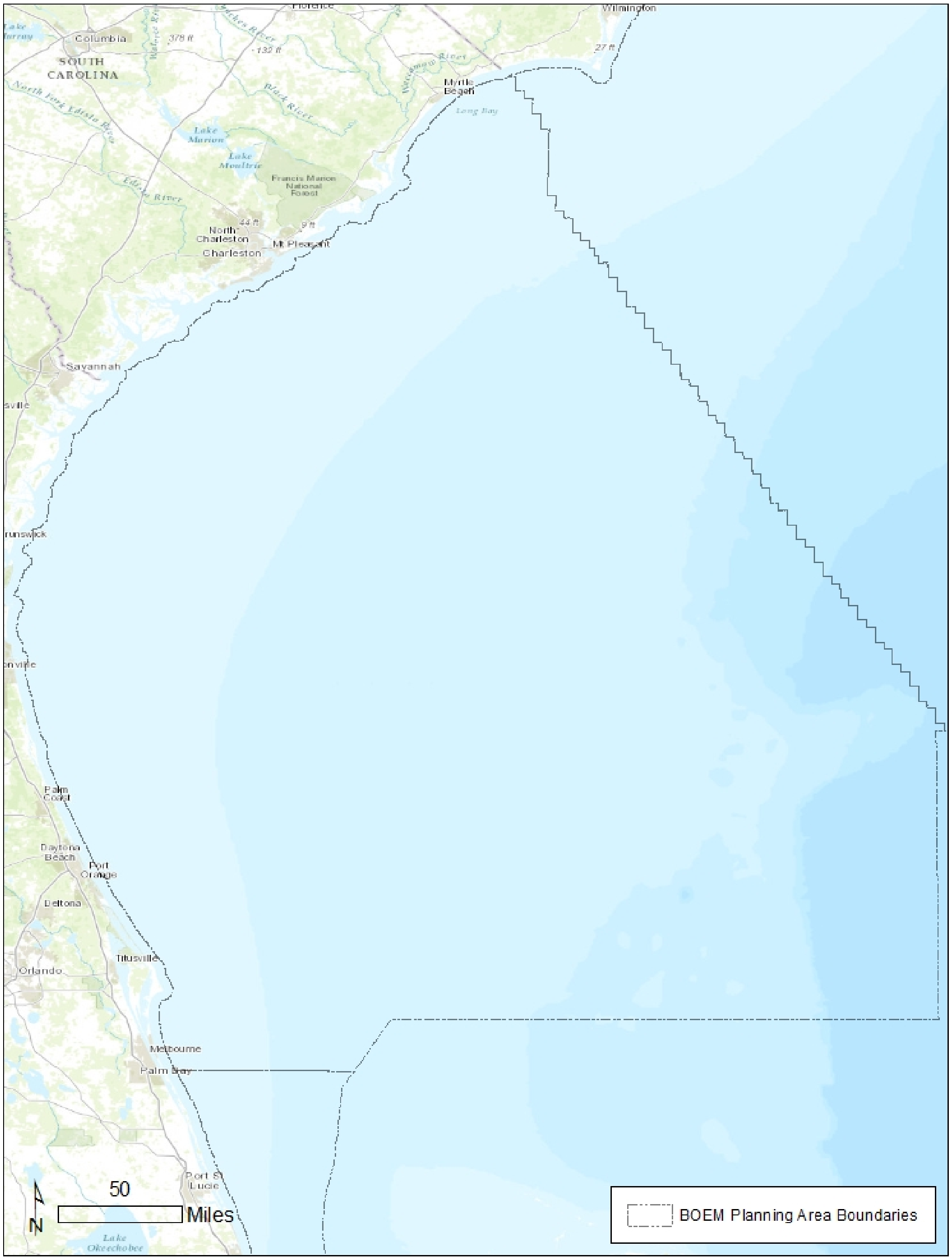


Figure 3-13. Area of interest for describing coastal habitats associated with the South Atlantic Planning Area.

3.2.4 Straits of Florida Planning Area

The coastal uplands of the Straits of Florida Planning Area (shown in Figure 3-14) can be characterized as Southern Coastal Plain, whose maritime upland communities are summarized in the above descriptions of the South Atlantic Planning Area, and the Southern Florida Coastal Plain, which runs south from approximately Jupiter, FL. Much of the coastal upland areas in south Florida have been heavily developed. In contrast, south of Miami-Dade County, the coast and islands of the Florida Keys have large areas of reserved federal lands, including Everglades National Park and several national wildlife refuges. Tropical hardwood hammocks are the climax terrestrial plant community in the Florida Keys, and are important stopovers for neotropical migrants in the keys (USFWS 2009). The Keys themselves are remnants of coral reefs that were formed when the sea level was higher. While these federal lands help to protect marine and terrestrial federally listed as threatened and endangered species, such as Key deer, expansion of tourism in the Florida Keys has limited wildlife habitats in upland areas (Kambly and Moreland 2009).

North of Biscayne Bay, Atlantic shorelines are sandy beaches on barrier islands, backed by shallow, coastal lagoons. The largest of these is the Indian River Lagoon, which extends 156 miles from north to south (IRLNEP 2016), extending into the South Atlantic Planning Region. Beaches in the region are important sea turtle nesting habitat. Four species of threatened or endangered sea turtles nest in this region, with some of the highest densities of loggerhead and leatherback nesting in the continental United States occurring in the Straits of Florida planning region (FFWCC 2016b). Beaches and dunes are heavily affected by development. Most beaches are in close proximity to urban areas; remaining undisturbed beach and dune systems are in protected areas (Marshall et al. 2014). Tidal flats composed of sand and mud or mud occur throughout the system, particularly behind barriers islands and within river deltas. Mangrove forests are commonly fronted by mudflats.

Rocky intertidal habitat generally does not occur; however there are some naturally occurring limestone outcrops that are present along south Florida beaches, in Martin and Palm Beach County. These outcrops represent the only extensive, naturally occurring rock cliffs described along the coasts of the southeastern United States, including South Carolina, Georgia, and Florida (Partyka et al. 2007).

Mangroves are the dominant wetland type south of Cape Canaveral and are ubiquitous in sheltered waters throughout the region, including freshwater areas (Odum et al. 1984). Oysters and SAV are present in sheltered waters. Shellfish reefs are not as expansive as they are in the adjacent South Atlantic Planning Area, but can be found in most estuarine areas, often associated with mangrove aprons. SAV within the Straits of Florida Planning Area occurs in the Indian River Lagoon, Lake Worth, Biscayne Bay, and Florida Keys, with the majority of the SAV concentrated in Biscayne Bay and the Florida Keys (SAFMC 2012). SAV is present in protected waters and serves as important habitat for many species of fish, invertebrates, and sea turtles, including several federally listed species. There are seven species of seagrass in Florida (FDEP 2013). Johnson's seagrass is endemic to the region, occurring only between Biscayne Bay and the Indian River Lagoon.

The Florida Keys hosts some of the largest contiguous tracts of SAV in the country, in close proximity to quality mangrove and hard-bottom and reef habitat. The coincidence of these three habitats makes the Florida Keys a highly productive and biodiverse ecosystem (NMSP 2007). South of Biscayne Bay, shorelines are protected from wave exposure by the reef tract and mangrove forest is the dominant shoreline type, covering 1600 islands and 1800 miles of shoreline within the Florida

Keys National Marine Sanctuary. Beaches are not common in the Florida Keys, however a few are present and support sea turtle nesting in the Dry Tortugas and the Marquesas. In addition, shell rubble beaches exist in some parts of the Keys, and serve as important nesting sites for the roseate tern (USFWS 1999).

The Florida straits region has the most coral reef and hard-bottom habitat of the four Atlantic planning areas. Most of these habitats are in shallow waters (less than 30 meters), and in some cases, they are exposed at low tide. The Florida Keys reef tract runs parallel to the Florida coast for almost 400 miles from the St. Lucie Inlet to the Dry Tortugas (FDEP 2016), forming one of the largest barrier reef systems in the world (NMSP 2007). More than 45 species of stony coral, 35 species of octocorals, and 70 species of marine sponges are found along the Florida Reef Tract (FDEP 2016), including two federally listed species, the staghorn and elkhorn corals.

Species composition along the reef tract changes as water quality and temperature change from south-north along the reef tract. Most of the coral reefs, which are formed by hermatypic corals, are found south of Biscayne Bay. The Florida Keys coral reef ecosystem is highly biologically diverse, and includes: 520 species of fish, including over 260 species of reef fish, 367 species of algae, 5 species of seagrasses, 117 species of sponges, 89 species of polychaete worms, 128 species of echinoderms, 2 species of fire coral, 55 species of soft corals, and 65 species of stony corals (NMSP 2007). Many commercially important fish and invertebrate species occur in reef habitats at some point in their life. The Florida Keys reef tract also supports a commercial marine life fishery, which collects animals for the aquarium trade (FFWCC 2016a). In addition, coral reefs concentrate nutrients, including carbon, through the filter feeding and structure-building behavior of sessile invertebrates, such as sponges and barnacles.

North of Biscayne Bay, the continuous reef tract is replaced by three discontinuous lines running parallel to shore, and the reefs transition to being dominated by soft corals (FDEP 2016). Areas of nearshore hard bottom also occur inshore of these reef areas (generally within 200 meters of shore), and provide nursery habitat for juvenile fishes. Lindeman and Snyder (1999) estimated that 34 species of fishes used nearshore hard-bottom habitats near Jupiter as nursery habitat. Sea turtles are also common on nearshore and mid-shelf reefs off of the Southeast coast of Florida. Worm reefs are also present in high-energy surf zones between Martin and Brevard counties (Kirtley and Tanner 1968), and are sensitive to physical disturbance. North of Stuart, as the Gulf Stream heads farther offshore, hard-bottom communities are more prevalent, similar to those found in the mid-Atlantic.

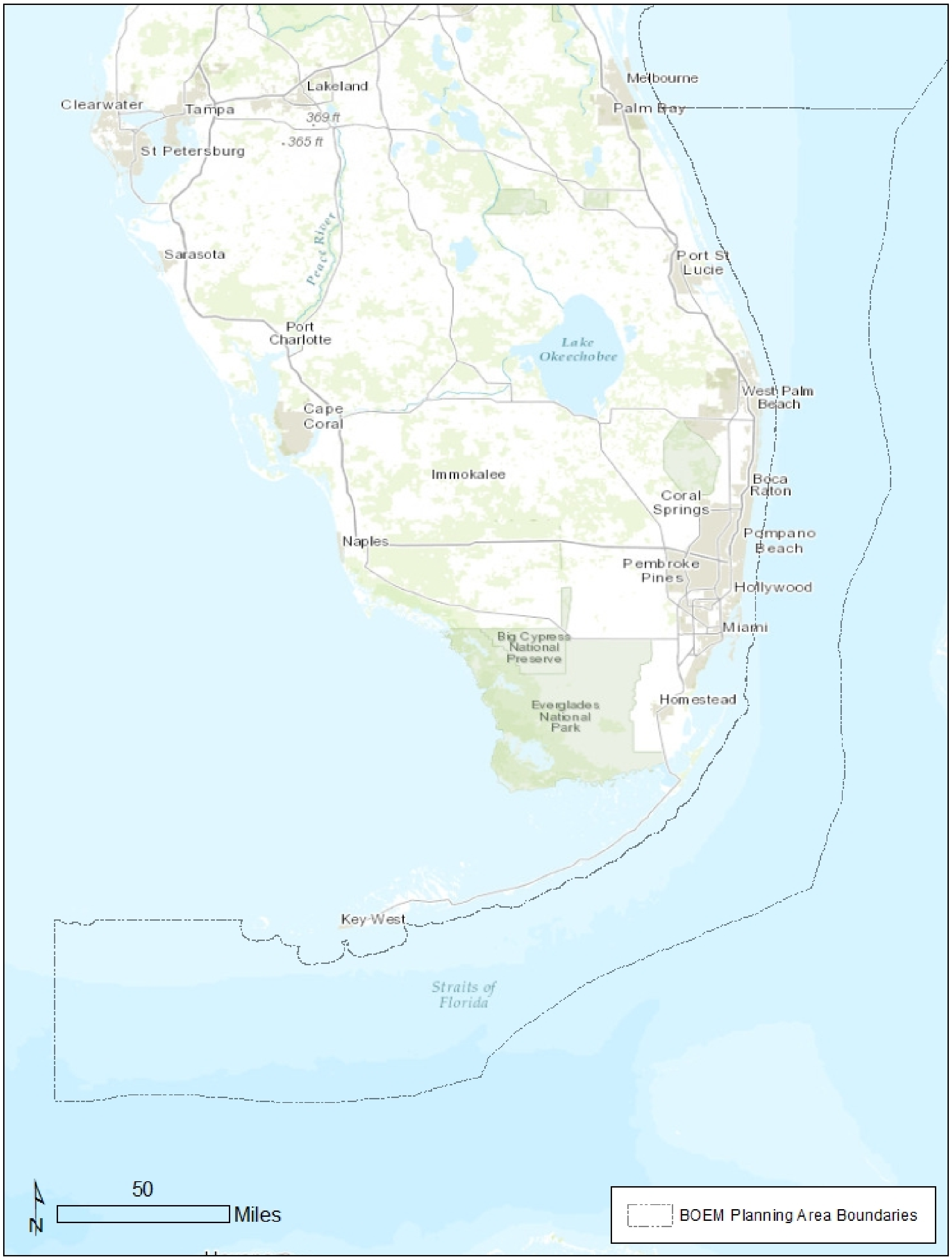


Figure 3-14. Area of interest for describing coastal habitat associated with the Straits of Florida Planning Area.

Chapter 4
Reasonably Foreseeable Construction and Operation Activities

Coastal habitats are threatened by anthropogenic stressors, including coastal development and habitat degradation (Kennish 2002; Kempton et al. 2005; Airoldi et al. 2008; Seitz et al. 2013). Often, degradation has modified coastal habitats to the degree that they no longer fulfil nursery, feeding, or reproductive functions (Beck et al. 2001; Worm et al. 2006). Adverse impacts on coastal habitats as a result of OSW facilities is a function of COP activities that directly or indirectly affect these habitats.

The purpose of the COP is to provide a description of all proposed activities and planned facilities for construction and operation of a wind facility under a commercial lease. Pursuant to 30 CFR 585.626, the COP must include a description of all planned facilities, including onshore and support facilities, as well as anticipated project easement needs for the project. It must also describe the activities related to the project including construction, commercial operations, maintenance, decommissioning, and site clearance procedures. The COP provides the basis for the analysis of the environmental and socioeconomic effects and operational integrity of your proposed construction, operation, and decommissioning activities. COPs are required to include:

- A description of the objectives for the project
- A description of the proposed activities, which should include: the construction procedure for installing equipment, project configuration and operation (e.g., turbine array, any electrical service platforms, the subsea power transmission cables, shore-side support infrastructure, and any other relevant information)
- A tentative schedule from start to completion, including the tentative schedule for all construction activities and for inspection and maintenance activities throughout the operational life of the project
- Any plans for phased development, pursuant to 30 CFR 585.629, or as directed in section (A) (2) of this guidance.

4.1 General COP Activities Common to Wind Facilities

As discussed earlier in this document, a single OSW facility has been approved for construction in federal waters. Therefore, although Block Island is located in state waters and is not under the purview of BOEM per se, it represents the most timely and relevant construction and operation details; therefore, the ER/COP for Block Island was the primary source of information related to COP activities presented here. The Cape Wind COP and VOWTAP RAP were reviewed for consistency with the Block Island Environmental Review/COP and Block Island USACE EA for the purpose of evaluating potential activities. For the most part, the analysis contained herein has relied upon the Block Island project to identify the bulk of COP activities due to its timeliness and use of best available technology. The development of offshore wind facilities includes five general components, occurring over approximately 2 years. Typically, the foundation and cables are installed one year, followed by the installation of the WTGs and commissioning in the second year, and operation and maintenance activities.

- Onshore Construction - substation construction, underground cable installation, overhead cable installation
- Landfall construction of cable and conduit connections
- Offshore Construction - foundation fabrication and transportation, mobilization, foundation installation, offshore cable installation, installation of the WTGs
- Operation and maintenance activities

A diagram of OSW components is presented in Figure 4-1. The WTGs are at sea and wind energy is transferred to a substation platform where it is transformed to higher alternating current (AC) power before it is transferred to the platform for direct current (DC) conversion, which conserves the energy as it is transferred via subsea cables to land. The DC energy is converted back to AC at the land-based converter station for the high-voltage, land-based grid and further transmission. Cable pulling vessels (Figure 4-2) and trenching are used to install the transmission cables. A diagram of OSW energy conversion and transmission is provided in Figure 4-3.

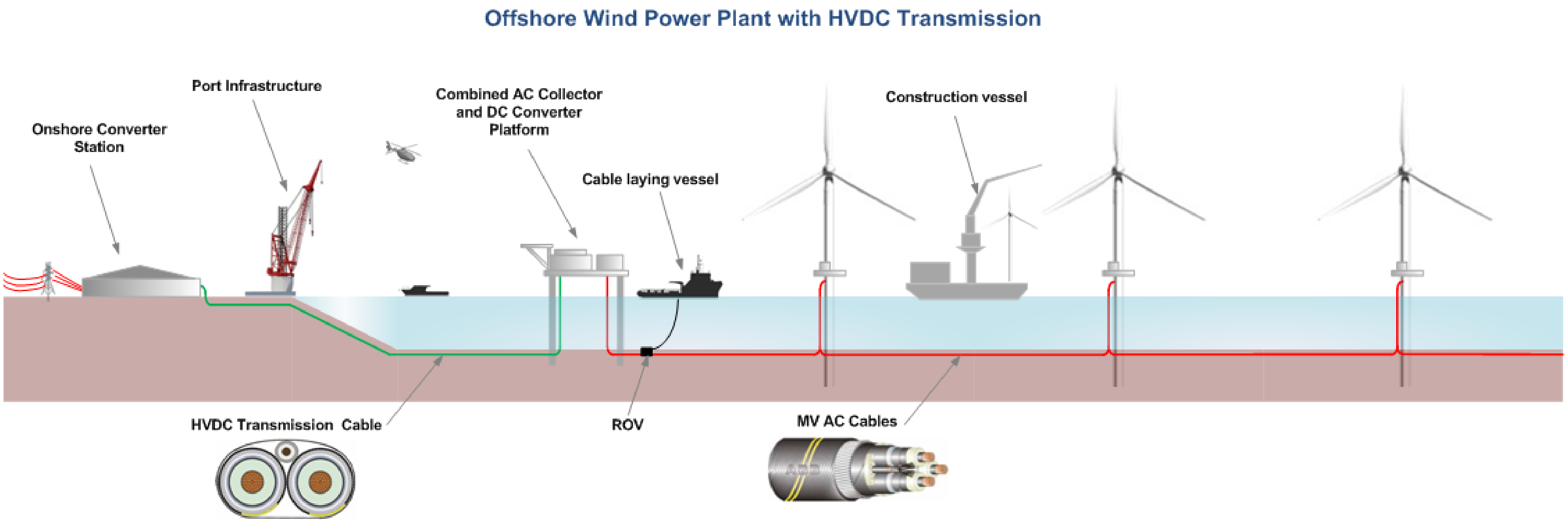


Figure 4-1. Diagram of OSW components (source: BOEM NREL 2014).

Figure 4-2. Cable-pulling vessels.

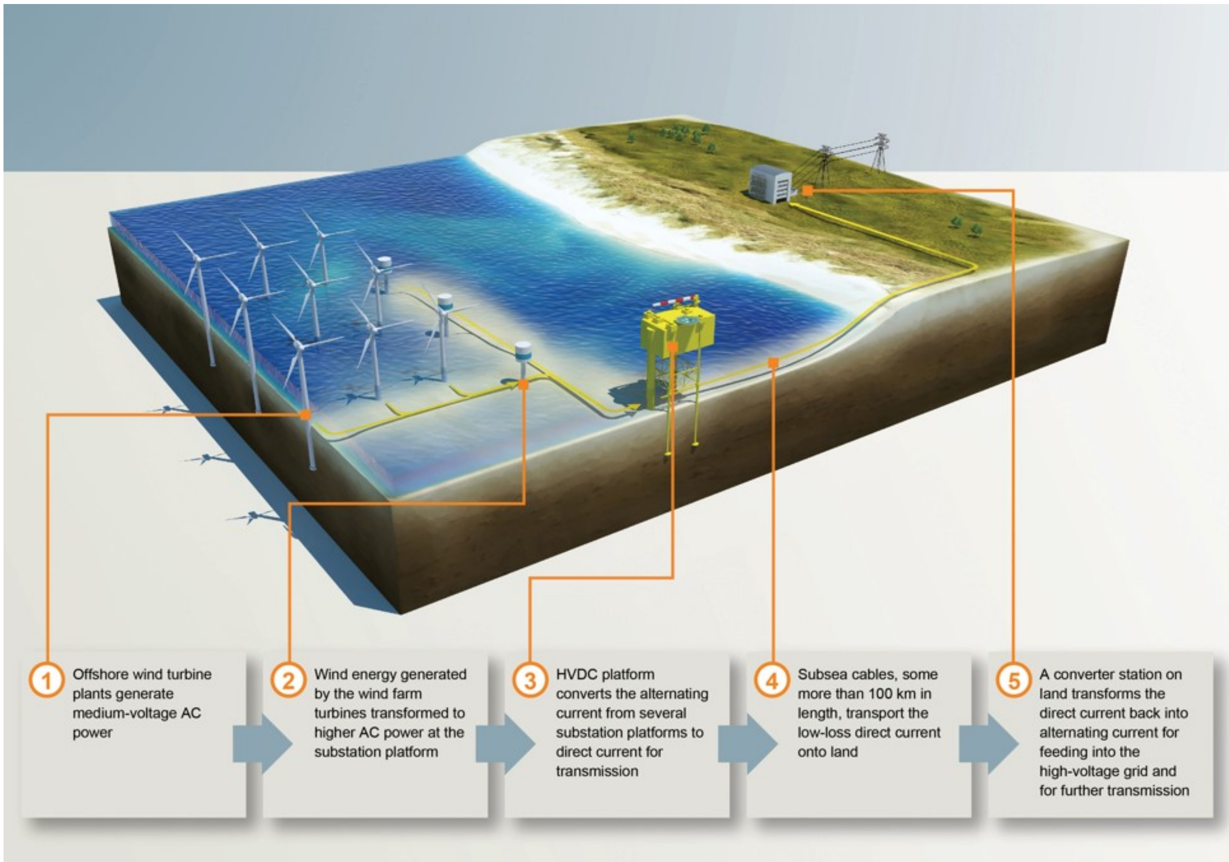


Figure 4-3. Representative diagram of OSW energy generation, conversion, and transmission to the land-based grid for further transmission (Source: Kilisek 2015).

4.2 Onshore Construction

Construction of port facility. Port facilities provide a base and staging for pre-assembly and construction of the OSW facility and separate locations may be used for providing foundations and the wind turbines to an OSW facility. Location of the facility is critical to managing the time spent required for shipment and "fair weather" windows for shipment. However, BOEM (*The Identification of Port Modifications and the Environmental and Socioeconomic Consequences*, BOEM 2016c), reported that while modifications are planned and underway, very few ports on the U.S. Atlantic coast are currently capable of fully supporting an offshore wind energy facility. The report highlighted 16 ports along the U.S. Atlantic coast that possess much of the required infrastructure deemed necessary for successful OSW project installation (BOEM 2016c). It should be noted that ports were highlighted based on existing infrastructure and capabilities but do not necessarily represent the best ports for an OSW project (BOEM 2016c).

Additionally, there is potential for some of the fabrication, particularly the turbine foundations, to occur at existing ports in the Gulf of Mexico (Bloomberg 2016). For example, foundations for the Block Island OSW facility were designed by Keystone Engineering, of Mandeville, and built by Gulf Island Fabrication in Houma, Louisiana. North Carolina's Port of Morehead City recently is also receiving wind turbine shipments for land-based facilities. Construction port requirements typically include:

- Minimum of 8 hectares suitable for pre assembly of the turbines
- A pier or wharf with a minimum length of 200–300 meters, a high load-bearing capacity, and access to ships and transportations
- Port access to water that accommodates vessels up to 140 meters in length, 45-meter beam and 6-meter draft with no tidal or other access restrictions
- Minimum overhead port clearance of 100 meters (to allow vertical shipment of towers)
- Sites with greater weather restrictions require a larger assembly area of up to 30 hectares

In the case of the Block Island project, 15 turbine tower sections and 15 blades have been delivered to ProvPort, in Providence, Rhode Island, and were shuttled from ProvPort to the project site by two offshore liftboats. The five nacelles for the five 6 MW turbines were transported across the Atlantic from the manufacturing facility in St. Nazaire, France, to the project.

Onshore converter station and associated activities. Operation of onshore facilities may include permanent onshore control room; permanent onshore service or staging area; permanent onshore warehouse area; shore termination of electrical cable; and onshore route for grid connection. A permanently maintained utilities right-of-way would be established if an existing right-of-way is not available. Other activities that may occur include installation of utility transmission poles and onshore vehicle use and travel necessary for post-construction maintenance.

4.3 Landfall Construction

Prior to the installation of the offshore portions of the export cable, landfalls are constructed where export cables are anticipated to come ashore. HDD can be used to install either a steel or high density polyethylene conduit for the cable in nearshore coastal habitats and under the beach (or other landfall habitat) to avoid impacts on habitat. Trenching after landfall is anticipated. The Block Island OSW facility describes a conduit that is up to 16 inches in diameter, requiring an HDD drill opening diameter of up to 24 inches. The HDD construction could be short-distance HDD from the onshore access location at a landside work area to near the mean high water line. A long-distance HDD from the onshore access location to temporary offshore cofferdams is an alternative to the short-distance HDD. The cable often is surfaced through a utilities access opening ("manhole") and landside activities typically take place in existing rights-of-way. However, the analysis of COP effects includes looking at landfall outside of an existing right-of-way. If cables cannot be buried to an adequate depth, concrete matting or rocks may be added to secure and protect the cables, similar to anchoring along subsea cables. The Block Island OSW facility anchored approximately 1% of the cable in this manner.

4.4 Offshore Construction

As previously described, COP activities to be included in the effects matrix were developed based on reviews of Block Island, Cape Wind, and VOWTAP construction and operation descriptions. While European OSW facilities are much more extensive than those in the U.S., e.g., the Block Island OSW facility has a 30 MW capacity compared with a capacity of 10,394 MW in Europe (Environmental and Energy Study Institute 2016), offshore facilities and construction for U.S. and European facilities are similar, simply because the U.S. relies on both capital and technology from Europe (Cusick 2016), despite the research lag behind the technology (Boehlert and Gill 2010). However, impacts of offshore activities are limited to offshore resources, rather than coastal resources, as described previously (e.g., DECC 2016, Bergstrom et al. 2014, OSPAR 2008), and offshore construction activities are therefore not particularly relevant to coastal habitats, with the exception of boat traffic. Descriptions of offshore construction activities are outlined below and are based primarily on those presented in the VOWTAP RAP (TetraTech 2015), Block Island EA (USACE 2014), and Cape Wind EIS (MMS 2009).

Export cable placement. These cables connect onshore and offshore substations and are typically buried 1.5 to 3 meters below the ocean floor to avoid potential disturbance due to non-OSW facility activities such as fishing and anchoring, as well as habitat impacts. Cable placement and burial are typically simultaneous, but a trenching ROV may be used to bury previously placed cable. Includes trenching and cable placement equipment/vessel(s). Vessels are typically 90 meters and dynamically positioned (DP2) for greater stability. Trenching ROV or jet plow/sled may be used to jet and "liquefy" sediments so that sediments fall back into place and burial is simultaneous. Cutting vessel would be used in rock or other substances inappropriate for jetting. Cable placement vessel is typically a barge. Jet plow/sled requires launching area and is towed by barge and tow tug.

Array cable placement. The cables are the power cables that are installed between the turbines and the offshore substation. Cables may be connected in a web type arrangement with a small number of turbines connected to a single cable that connects to the substation, or as branches along the primary cable with 6 to 10 turbines on each. Jet plowing close to the turbine and substation can be difficult and a trenching right-of-way may be used to bury the cable at these locations. Array cables have been installed using a DP2 vessel, which provides more efficient setup and installation time and can remain on station in higher sea states and wind conditions compared with a barge due to its stability and reduced impacts on habitat. The Block Island project includes four inter-array cables connecting the five wind turbine foundations and the export cable connecting the OSW facility to a new substation on Block Island.

Foundation installation. Foundation placement can vary with the technology used. Monopiles are typically driven from a jack-up vessel but can be drilled and installed using a floating vessel, while jacket and tripod foundations may be installed by floating cranes. The monopile is a cylindrical steel tube embedded into the ocean floor, with a diameter up to 6 meters and weighing as much as 650 tons. It may also be concrete embedded into the ocean floor or a floating design. For turbines 5 MW and larger, jackets or tripods in steel or concrete gravity foundations are typically used. For jacket and tripod foundations pin piles are driven into the seabed and the foundation lowered onto the pile heads and grouted into position. Gravity base foundations may use floating cranes or specialist barges to support float out. Monopiles are driven into the ocean floor using a hammer and anvil system before mounting transition pieces and feeding the cable into the foundation. Offshore substation foundations may be installed in a way similar to turbine foundations but are significantly larger. Cables are drawn from the ocean floor through the foundation base and into the wind turbines. Foundation installation vessels are typically a self-propelled jack-up vessel, up to 140 meters long with 6-meter draft and speeds to 11 knots. Foundations are transported from portside to the construction site and secured to the ocean bottom. Foundation installation requires a hammer/anvil system to drive piles, which are then grouted in position and an on board crane is required.

Offshore substation installation. The offshore substation is transported to and lifted onto a pre-installed foundation, typically using a floating crane. The substation transmits the power generated by the wind turbines to the mainland via the submarine export cables and is where the electricity generated by the OSW facility is typically converted from AC to DC voltage (to reduce energy loss) before it is transferred to the onshore converter station that converts the voltage back to alternating current for transfer to the local electrical grid.

Offshore support. A number of vessels are used to support the installation process including cable, wind turbine, substation, foundation, and other offshore structure installation. These vessels may include crew vessels, anchor handling, barges, dive support, and ROV support. Crew vessels are used to transport crew members to the OSW facility for installation and commissioning tasks. These vessels are typically 15- to 20-meter catamarans. ROV and dive support vessels are 80- to 100-meter DP2 vessels with a deck crane.

For example, the Block Island project had five steel jacket foundations installed during an 18-week construction period by approximately 200 workers and a dozen construction and transport barges, tugboats, crew ships and monitoring vessels active at the project's port facilities and the wind facility site. Ultimately, the number of workers, period of construction, and other vessel and facility requirements would be based on the size of the proposed OSW facility, type and quantity of equipment used, frequency/duration of activities, number of crew, and distance of the OSW facility from ports and staging locations.

Turbine installation. Turbine installation includes transporting the turbine components from the construction port and installing the turbine on the foundation. Installation methods vary and include assembly of turbine tower, nacelle (the housing cover for the generating components of the turbine) and blades at sea and transfer of complete turbines from land. A turbine installation vessel is required, which is typically about 130 meters in length with DP2 and speeds of 11 knots.

Figure 4-4. Wind turbine at Block Island, Rhode Island facility. *Photo credit: Whitney Fiore.*

Commissioning. Once construction is completed, post-construction activities begin and may require approximately 2 days for an individual turbine. Commissioning includes electrical testing, inspection of engineering records, safety-critical and auxiliary systems, and other activities to ensure the facility is operating correctly. A warranty is typically provided to cover lost revenue, including downtime to correct faults, and a test of the power curve of the turbine. After commissioning, the OSW facility is transferred to the operations and maintenance crew. Typical routine maintenance time for a modern wind turbine is 40 hours per year and non-routine maintenance may be of a similar order.

Emerging Technologies. It is worth noting that offshore wind energy development is experiencing rapid technological advances. One example is use of suction buckets for installation of foundations that lower upturned buckets into marine sediment to anchor structures, which reduces noise and seafloor disturbance during construction. The matrix has been set up to provide update capabilities as these technological advances are proven and used in future OSW facilities.

4.5 Operation and Maintenance

Operations of OSW facilities includes monitoring, control, coordination, and administration of the facility. Maintenance includes the attention to turbines and the associated facilities that keep the turbines running, which includes scheduled and unscheduled maintenance. Scheduled maintenance includes annual activities such as fluid level checks, greasing, bolt torque checks, filter changes, inspection of blades, inspection of brake pads, and electrical activities. Unscheduled maintenance includes unplanned activities that typically occur offshore may be simple turbine faults or trips or major component failures. Operational support and monitoring for an OSW facility is typically 24/7, 365 days a year, including response to unexpected events (Tavner 2012). OSW facilities are monitored remotely using supervisory control and data acquisition and condition monitoring systems as well as active inspections, including of submarine infrastructure. Scheduled and unscheduled activities require regular transfer of personnel to the wind turbines and onshore and offshore substation. The EA for Block Island (USACE 2014) indicates 3 to 5 days of planned maintenance per year for each wind turbine (not repairs) for the Block Island facility, compared with 240 hours per turbine per year for preventive maintenance for the VOWTAP RAP. Using a crew transfer vessel and offshore accommodations, a 24/7 work shift was found to be the most efficient in at least one study (Besnard et al. 2012). Key requirements are vessels that can operate in adverse weather conditions, for example 20-meter catamarans with capacity for 12 technicians (Besnard et al. 2012). Vessel speeds can be over 20 knots and are designed to transfer maintenance team members safely to the OSW facility to perform work. Helicopters can provide access to turbines and offshore substations or accommodation, especially when weather conditions prevent access by boat and can accommodate five technicians.

4.6 Decommissioning

Decommissioning of an OSW facility would likely occur after 20 to 25 years, which is the typical design life of an OSW facility project. Decommissioning would entail dismantling of the WTGs and the electric service platforms and their foundations; removing scour protection structures; and transporting these materials to shore. The WTGs would be dismantled in the same manner that they were assembled, with similar equipment, only in reverse. During the decommissioning phase, monopiles may be cut and removed to a depth of 4.6 meters (15 feet) below the seabed, or they may be left in place to be converted to other uses. Gravity foundations may be removed and transported back to shore or left in place. During these activities, the facility would encounter the same project impacts (mainly due to seafloor disturbance) and risk of geological or meteorological events as would be present during the facility's construction. Typical decommissioning is anticipated to include the activities outlined below, based on a review of decommissioning activities described for Block Island, Cape Wind, and VOWTAP OSW facilities.

- Contracting, mobilization, and verification. This phase would include finalization of contracts with vendors, recycling contractors, and offshore contractors. An operation and maintenance crew boat may be used to support project activities. A third-party environmental inspector may be employed to monitor construction and decommissioning activities.
- Offshore construction
  - Mobilization - Removal of the WTGs. This phase of decommissioning is for the offshore components of the OSW facility and includes the completion of final detailed construction plans, procurement of necessary vessels and other equipment for construction activities, offshore cable abandonment, WTG and foundation removal, and demobilization.
  - Foundation removal – a derrick barge will be used to remove equipment and prepare the deck for lifting. The deck will be cut free from the foundation and lifted onto a barge for transport to a recycling facility. Water jetting will be used to evacuate soil plugs from piles and piles will be cut with a water jetting tool approximately 10 feet below the ocean floor. The pilings, then the foundation jackets, will be lifted onto a barge and transported for recycling.
  - Offshore cable abandonment in place – inter array and export cables formerly attached to piling jackets will be severed approximately 4 feet below the ocean surface and placed on a barge. Submerged and buried cables between WTGs and to the landward facility will be abandoned in place.
- De-mobilization. After removal/abandonment of pilings and cables, any remaining debris will be removed and the barges demobilized from the site.

Chapter 5
Potential Direct and Indirect Environmental Effects of COP Activities on Coastal Habitats

Potential environmental effects on coastal habitats are very different from those associated with the impacts of the OSW facility COPs on resources proximate to, for example, the OSW turbines. The primary environmental impacts associated with OSW facility COPs occur offshore and include noise (pile driving and other construction activities), wildlife collisions with turbines, disturbance/loss of benthic and pelagic habitats, changes in biodiversity and food web alterations (e.g., colonization of OSW structures), and contamination due to increased vessel traffic or sediment resuspension (Bailey 2014 et al.; Boehlert and Gill 2010; Gill 2005). In addition, evidence regarding adverse effects of power cable EMF associated with the wind turbines on marine species is reportedly increasing (Kaplan et al. 2011), although there is little to no evidence of impacts related to habitat exposure from EMF associated with buried transmission cables (Gill and Bartlett 2010). Impacts on coastal habitats are expected to be minor to major when expanding into areas of previously undeveloped coastal habitat (Whitney et al. 2016; Wilson et al. 2010; NOAA 2008; Hiscock et al. 2002). Because this white paper addresses impacts on coastal habitats rather than offshore and species-specific habitats, potential impacts of wind turbine placement and operation offshore on proximate resources are not carried through for further analysis in this white paper.

Potential direct and indirect environmental effects of COP activities on coastal habitats relied on several assumptions in the absence of project-specific information. Assumptions made with respect to potential impacts of COP activities on coastal habitats are listed below and discussed further in this section.

- The list of COP activities for future proposed projects is similar to COP activities developed from the Block Island, proposed Cape Wind, and VOWTAP projects.
- Landfall and land-based facilities do not occur in federally designated critical habitat, national or state parks, Marine Protection Areas, or other areas designated similarly.
- Landfall of proposed projects does not occur in an existing right-of-way. Consequently, a coastal habitat was evaluated under the assumption that the activity intercepted the habitat.
- Activities include no minimization, avoidance, or mitigation.
- Cable installation activities include plow-trenching at landfall and HDD for subsea cable placement.

In general, construction staging activities at both land side and proximate port facilities were considered temporary. Cable trenching was considered a habitat removal, but not permanent. Consequently, most impacts were a result of cable burial via plow trenching, landfall activities of HDD, erosion as a result of vessel-induced wave action, and utilities and transmission easement construction.

As part of the COP approval process BOEM develops terms and conditions for projects that prioritize avoidance of, and minimization of impacts on, sensitive coastal habitats for cable landfall and other onshore activities as appropriate. For example, if a wind developer submitted a COP that identified a cable landfall within SAV or a nursery estuary, BOEM would work closely with the developer to identify alternative locations that would reduce or avoid those effects. In looking at Cape Wind or VOWTAP, for example, the cable landfall occurred within an existing right-of-way in areas already disturbed or covered by concrete. Another reason that existing rights-of-way are likely to be selected is the proximity of these areas to existing infrastructure and urbanized areas, where power is typically used.

In order to present an effects matrix that assists BOEM and wind developers in identifying potential impacts on coastal habitats, it is necessary for the matrix to identify and make effects determinations assuming that avoidance and minimization are not included in the decision-making process. This is done for two reasons: (1) it provides the matrix user with an efficient method for checking the extent of effects on the various coastal habitats from COP activities and deciding if an alternate landfall area should be considered; and (2) it allows BOEM to present the conservative (or worst-case scenario) effects on coastal habitats. It is important to keep in mind that as BOEM completes NEPA analyses and issues RODs for future OSW facilities, the effects determinations that will be added to the matrix for incorporation by reference into other NEPA documents would not likely be for the worst-case scenario (e.g., major, long-term effects). Through BOEM's COP approval process that includes avoidance and minimization of these effects and with incorporation of best management practices, future effects determinations for coastal habitats would likely not be significant. The effects matrix also assumes that cable landfall or other onshore construction would not occur within habitats such as wildlife refuges, designated critical habitat, or other special-status coastal habitats.

Construction and operation activities (or actions) that affect coastal habitats include vessel traffic, construction and operation of onshore facilities, installation and operation of electric transmission cables, expansion of ports and docks, and operation of offshore wind energy components that can result in sediment suspension, habitat disturbance and loss, contamination, and other adverse effects (EMEC 2008; MMS 2007a; Michel et al. 2007). The disturbance of beaches, dunes, and other coastal habitats by cable installation may result in direct habitat losses from excavation, sedimentation, stormwater runoff, accidental loss of drilling fluid, and erosion adjacent to the cable route which may indirectly affect coastal habitats during construction and installation. While these actions are relatively easily defined, the effects (sediment loss, contamination, etc.) are frequently interactive and less easily defined (e.g., clearing can result in habitat loss which leads to introduction of invasive/nonnative species which leads to more habitat loss). Environmental effects on coastal habitats would be largely influenced by site-specific factors, such as the habitat types and distribution in the vicinity of a wind energy project (Michel et al. 2007; MMS 2007a; Gill 2005).

Although species, recreation, and other uses of coastal habitats may be affected by noise associated with COP activities occurring in coastal habitats, those effects would be addressed in their corresponding section within a NEPA analysis (e.g., noise effects from cable landfall or transmission line placement [likely HDD]to nesting birds would analyzed in biological resources under the avian discussion). Impacts on coastal habitats due to COP activities have received little attention in the literature, which focuses primarily on the larger impacts of noise and collisions on bats, birds, marine mammals, and turtles, and colonization of structures. Reasons may include the smaller footprint when compared with offshore WTG construction and operation, a focus on species rather than habitats, and the difference in regulatory jurisdiction for onshore and state waters (USACE) rather than federal waters on the OCS (BOEM).

However, based on the literature (Hiscock et al. 2002; Shumchenia et al. 2012; Rostin and Herkül 2013; Bailey et al. 2014; Riefolo et al. 2016) and COPs (Cape Wind and Block Island OSW facilities) reviewed, six categories of environmental effects were identified for a matrix evaluation in this white paper (presented in Chapter 6). These effects are listed below and described with respect to coastal habitats.

Impacts of OSW COP activities on coastal habitats are similar to dredge impacts, but are relatively smaller due to common use of HDD at landfall. For example, operation and maintenance of transmission line rights-of-way typically include chemical or mechanical control of vegetation that can contribute to the loss of native plant species diversity, and cleared rights-of-way may be a continuous source of sedimentation into waterways (NOAA 2008). Importantly, the Block Island and Cape Wind OSW projects proposed landfall and landside activities in rights-of-way to avoid impacts on habitat. Consequently, impacts of landfall and landside trenching, jet plowing, clearing, and construction of facilities were considered negligible to minor when co-located with existing rights-of-way. Impacts on coastal habitats include sediment disturbance, erosion, clearing, direct habitat removal, invasive/nonnative species, contamination. Potential impacts of these activities are summarized below.

- Sediment disturbance occurs due to construction, jet plowing and cable installation, vessel and wave disturbance, and disposal of excavated sediments during landfall and nearshore OSW facility COPs. Disturbance, including include physical disturbance, damage, displacement and removal, has been identified as a major impact of OSW facilities (Meisner and Sordyl 2006). It can result in both loss and degradation of soft-bottom, SAV, reef, and other nearshore habitats (Michel et al. 2007; Erftemeijer and Lewis 2006). Physical removal of sediment and associated biota and subsequent deposition and burial are the most likely direct effects (Thrush and Dayton 2002). Impacts on coral reefs, for example, are related to the intensity, duration, and frequency of exposure to increased turbidity, and recovery depends on antecedent and reef resilience (Erftemeijer et al. 2012). Studies of dredging impacts indicate rapid (1 to 3 years) in sandy and muddy habitat (Bejarano et al. 2013). Recovery slow on coarse and more stable substrata (Gill 2005).
- Erosion of coastal habitats due to OSW facilities results primarily from increased vessel activity and commensurate increases in wave action, leading to both loss and degradation of habitat (TetraTech 2015). Beach or dune substrates may be difficult to stabilize, and erosion may occur adjacent to the cable route, affecting intertidal habitats such as tidal flats, reefs, and beaches, and may also exacerbate existing erosion rates, for example, shoreline retreat occurs at a steady rate of 2 meters per year at South Nags Head, North Carolina (Thieler et al. 2001). Loss of tidal marsh vegetation could result in erosion of marsh substrates, with subsequent conversion of marsh habitat to open water. Locally generated wind waves account for most of the wave force acting on exposed bank, however, while vessel generated waves accounted for only about 5% of cumulative wave energy, vessel generated height and period increases accounted for up to 25% of the cumulative wave source, resulting in a significant increase in local shoreline erosion (Lambkin et al. 2009; Houser 2010). Similarly, changes in wave climate, tidal prism, and currents, affect erosion and therefore marsh retreat (Cox et al. 2003). Downstream effects of these changes can affect intertidal habitats (Gill 2005). Beach and barrier island dune stability is also strongly affected by disturbances associated with sand movement (Miller et al. 2014) and can result in erosion or accretion hotspots on adjacent shorelines. Vessel generated wave activity can affect marsh habitats and shoreline erosion in general (Gourlay 2011; Houser 2010; Reed 2012). In addition, erosion can increase turbulence and turbidity, reducing light available to SAV habitat and/or placing stress on reef habitats.

- Clearing activities for transmission rights-of-way results in direct habitat loss that can be replaced by other habitats and is not necessarily permanent. Additional power transmission utilities and right-of-way result in loss and fragmentation of terrestrial habitat (NRC 2007; Gehring et al. 2009) and may also have extensive impacts on ecosystems (Sanchez-Zapata et al. 2016). To date, cause and effect between exposure to magnetic fields along rights-of-way have not been established (PSCW 2013). Construction and maintenance of transmission lines typically removes individuals but does not threaten populations. However, fragmentation of interior forest and increased edge habitat can be particularly destructive to forested habitats. The construction and maintenance of transmission lines affect coastal wetland habitats due to degradation and compaction from heavy machinery, increased runoff, flow alterations, invasive species opportunities, and overall loss of habitat.
- Removal of habitat by replacement with permanent structures such as onshore substations and other facilities results in direct loss of habitat. Disturbance of beaches, dunes, or other coastal habitats by the onshore inter-connection cable and fiber optic cable may result in direct habitat losses from excavation as well as indirect impacts (TetraTech 2015). Recolonization of native habitats may take months to years after restoration (Bradshaw 2000). Direct loss of coastal habitats can result in a loss of buffer, nursery, feeding, or reproductive functions for organisms (Airoldi et al. 2008). Costanza et al. (1997) estimated that loss of ecosystem value with loss of coastal habitats, "such as seagrass beds, intertidal habitats, and saltmarshes, is appreciably higher per unit area than those provided by terrestrial habitats." Coastal habitat loss due to OSW facilities would include nearshore, landfall, and onshore construction and operation activities that result in direct loss of habitat, e.g., trenching, and construction of substation facilities.
- Invasive/nonnative species introduction and/or expansion may occur particularly after ground disturbance. Coastal estuarine and marine systems are reportedly among the most heavily affected due to invasive and nonnative species (Grosholz 2002). Some non-native species are able to become quickly established, are highly tolerant of a wide range of conditions, are easily dispersed, and subsequently are able to successfully out-compete native species for habitat and resources, reducing biodiversity, and negatively affecting both ecological communities and wildlife habitats (Didham et al. 2007). Disturbance of native habitats, including transmission line construction, vehicles, and access points contribute to the spread of invasive species. Habitat providing food and cover for local wildlife may be altered or lost if these invasive species outcompete existing native plants, resulting in a loss of plant and animal diversity (PSCW 2013).
- Contamination due to spills (and/or resuspension) may be introduced in stormwater runoff or in discharges from vessels. During deployment, servicing, and decommissioning, expected risks associated with marine vessel operation encountered and potential for spills exists. Continuous leaching of anti-fouling paints from vessels may also occur. Onshore sediment and other contaminant runoff are likely during construction activities. Indirect impacts from HDD used for cable installation could include accidental losses of drilling fluid. Fuel and chemical spills could occur as results of vessel collisions and allisions or leaks or from chemical releases, including oils associated with routine operations and maintenance of offshore wind turbines. Contact with diesel fuel from backup generators or turbines could result in injury or mortality of wetland vegetation and coastal habitats. Spilled fuels could penetrate beach substrates or could persist in coastal habitats.

Coastal habitats may be affected differently by the COP activities described above, depending on location and proximity to trenching, transmission line surfacing, directional drilling, transmission right-of-way clearing, and other activities. Coastal uplands would likely be impacted by rights-of-way and utilities installation activities as well as right-of-way maintenance. HDD would avoid extensive impacts, especially if the drilling surfaces at an existing right-of-way and if any additional utilities are constructed in an existing right-of-way. Noise and air quality impacts would also be anticipated during construction. This habitat is terrestrial and not subject to the direct effects of the jet plowing and vessel activity that shoreline habitats would be. In general, negligible to major effects on these habitats from COP activities are anticipated, major effects being due to installation of facilities outside an existing right-of-way.

The effects of the COP activities on coastal habitats that make up the shoreline, such as dunes, beaches, and marshes, would be expected to be greater when compared to those on coastal uplands due to the landfall footprint and activities associated with landfall. Jet plow launching, additional vehicle and pedestrian activity, staging activities, and HDD could affect beaches, dunes, marshes, and intertidal habitats directly if transmission lines intercept the habitat directly or occur close enough to result in sedimentation and vessel disturbances. Direct loss of habitat, either permanently or temporarily, may occur. Erosion and loss of shoreline may occur. Noise and EMF effects may also occur. Effects on these coastal habitats, i.e., dunes, beaches, marshes, and wetlands, as a result of COP activities are anticipated to range from minor to major, depending on their position relative to the transmission landfall.

Tidal flats and submersed coastal habitats such as rocky intertidal zones, shellfish and coral reefs, SAV, nearshore soft bottom, and the water column are typically outside the footprint of transmission landfall and therefore expected to be subject to fewer direct effects than the marshes and beach habitats. Trenching and sedimentation, temporary or permanent burial, and possibly EMF effects would be expected if these habitats are intercepted by, or in the vicinity of, trenching and staging activities. Recovery of these habitats is anticipated to be faster than for shoreline habitats, depending on the proximity to the impact. Effects of COP activities on tidal flats and submersed coastal habitats would be anticipated to be negligible to major.

A summary of coastal habitats and corresponding ecosystem values, potential effects of COP activities on the habitats, and references used in evaluation of the effects is presented in Table 5-1.

Table 5-1. Ecosystem Values and Potential Effects of COP Activities on Coastal Habitats

Coastal Habitat	Ecosystem value	Potential effects of COP activities	References
Coastal uplands	Shoreline protection from storm surge, flooding, SLR, water quality improvement via filtering, terrestrial organism habitat.	Forest fragmentation and edge effects, invasive species expansion, vegetation community shifts, reduced storm surge protection, increased debris, slow vegetation recolonization, water quality impacts due to stormwater runoff during construction and utilities maintenance, chemical spills and groundwater contamination, noise and physical disturbance during construction and maintenance activities	Sanchez-Zapata et al. 2016, Bartzke et al. 2014, Arkema et al. 2013, Nonnis et al. 2013, Resasco et al. 2014, Ball 2012, Gehring et al. 2009, Strevens et al. 2008, Hiscock et al. 2002, Bradshaw 2000, Collinge 1996, Bellis 1995, Andrews 1990.
Dunes and beaches	Shoreline protection from	Erosion and changes in sediment (sand) transport and deposition due	Miller et al. 2014, BOEM 2015, USACE 2014, ELI 2013, ABP

Coastal Habitat	Ecosystem value	Potential effects of COP activities	References
	waves, storms, SLR; shorebird habitat.	to vessel-generated wave energy, increased debris, increased turbidity, chemical spills, disruption of the sediment profile, temporary benthic habitat loss due to cable installation, disturbance of archaeological sites.	Marine Environmental Research 2012; SEAI 2011, Feagin et al. 2005.
Tidal flats/rocky intertidal zone	Shoreline protection from waves, storms, SLR; water quality filtering; fisheries habitat; contaminant resuspension.	Direct loss of habitat due to construction activities, resuspension of contaminated sediments, sediment burial, erosion due to increased vessel-generated wave activity.	Bailey et al. 2014, Barbier et al. 2011, Boehlert and Gill 2010, NOAA 2008, Worm et al. 2006, Meisner and Sordyl 2006, Gill et al. 2005, Wilber and Clark 2001.
Tidal marshes	Shoreline protection from waves, storms, SLR; fisheries habitat; water quality filtering.	Erosion, retreat, and loss due to wave energy and disturbance due to cable installation and vessel induced wave action, contaminant resuspension, sediment profile disturbance, sediment burial, chemical spills. Considered minor to major depending on methods.	Silinski et al. 2015, Barbier et al. 2011, Callaghan et al. 2010, Houser 2010, Gedan et al. 2010, NOAA 2008, Meisner and Sordyl 2006, Worm et al. 2006, DeLuca et al. 2004, Cox et al. 2003, DeLuca et al. 2004, Gourlay 2011; Houser 2010, Reed 2012.
Submersed SAV, reefs, nearshore habitats and water column	Shoreline protection from waves, storms, SLR; fisheries habitat; water quality filtering.	Sediment burial during cable installation, changes to wave regime due to vessels, contaminant resuspension during cable installation, EMF from cables, direct habitat loss or irreversible changes due to cable installation, potential chemical spills during construction and maintenance. Little to no impact of EMF. Considered minor to major depending on methods.	Silinski et al. 2015, TetraTech 2015, DOE 2015, Bailey et al. 2014, Erftemeijer et al. 2012, Shumchenia et al. 2012, Scyphers et al. 2011, Kaplan et al. 2011, Gedan et al. 2010, Lambkin et al. 2009, NOAA 2008, Barbier et al. 2008, Bilkovic and Roggero 2008, Michel et al. 2007, Bilkovic et al. 2006, Erftemeijer and Lewis 2006, Gill et al. 2005, Walhberg and Westerberg 2005, Austin et al. 2004, Thrush and Dayton 2002, Wilber and Clarke 2001.

Chapter 6
Matrix of COP Activities and Effects Determinations

An effects matrix was developed as a tool to evaluate potential effects of OSW facilities on coastal habitats along the U.S. Atlantic coast.[5] The intent of the matrix is to provide a tool that can be used to efficiently quantify potential impacts of OSW facility COPs on coastal habitats specifically. Beginning with the MMS FPEIS (MMS 2007a), "most impacts would be negligible to moderate for all phases of wind energy development assuming that proper siting and mitigation measures are followed...Construction activities such as transmission cable installation and construction of onshore facilities could result in negligible to moderate impacts to coastal habitats (e.g., wetlands, barrier beaches)...Such impacts could be avoided through the use of noninvasive techniques and avoidance of sensitive areas." From the MMS FPEIS (MMS 2007a):

- Effects of wakes on coastal habitats are expected to be negligible.
- Installation of an electric transmission cable and construction of facilities for offshore alternative energy projects to avoid or minimize impacts to sensitive resources and comply with federal, state, or local regulatory agencies and "therefore, impacts from construction of facilities and installation of power cables would likely result in negligible to moderate impacts to coastal habitats."
- Intertidal and shallow subtidal coastal habitats, including seagrass beds, wetlands, mudflats, and beaches, may be directly affected by the expansion of existing docks and ports to accommodate the number and size of vessels needed for construction of wave energy conversion facilities.
- Impacts on coastal habitats from offshore spills are not anticipated. However, spills during towing between the OSW facility and port facilities may be transported by currents or tides to coastal wetlands or beaches. Because of the small amount of fluids that would be present, impacts would likely be negligible to moderate. Negligible impacts that result from management of nonhazardous wastes (e.g., bentonite for HDD activities) generated offshore during construction of ocean current energy projects are anticipated.

More recent documents, for example the Environmental Report for the Block Island OSW facility and more recent literature, have identified potential impacts of cable installation and landfall activities on coastal habitats (see Chapter 2 review). The level and duration of potential adverse impacts described in these documents, combined with the baseline information (presented in Chapter 3) were the basis of the individual effects determinations presented in the effects matrix. The expansion and operation of port facilities can result in emissions, expansion into undeveloped areas, vessel-induced wake erosion, increased dredging, and effects on air and water quality and coastal habitats (Whitney et al. 2016). During dredging, noise and air quality impacts are frequently mitigated by the use of best management practices, mitigation for loss of intertidal areas, mud flats, and important bird habitat has included development of substitute sites of sufficient size and habitat diversity (Whitney et al. 2016).

Shumchenia et al. (2012) and McCann (2012) propose a monitoring framework and standardized protocols to address anticipated effects of OSW facilities on marine ecosystems, based on a

[5] The Effects Matrix is an electronic data tool and is available separately on BOEM's website or by contacting BOEM.

literature review of potential impacts. Both studies focus on the effects of installation and operation of the turbines, e.g., blade strikes, pile driving, and scour around foundations, on the marine ecosystem rather than coastal and estuaries. However, both also reference minor, but highly certain, impacts of cable installation (including trenching) on benthic habitats for wind turbine installation involving pile installation.

6.1 Matrix Development and Intent

The outcome of the effects matrix is a result of user-entered, project-specific data. In the absence of project-specific data, assumptions have been made to understand how the effects evaluations were developed for this white paper, as described in Chapter 5. An effects matrix was developed that first allows determinations of intensity, context, and duration (ICD) by habitat and then compiles the results of the ICD determination into single rankings for each combination of coastal habitat and COP action. Coastal habitats were developed and described earlier in Chapter 3, COP activities were described in Chapter 4, and potential effects of COP activities were described in Chapter 5. The effects matrix provides a tool for making overall effects determinations that include ICD rankings for each action for each habitat. The matrix can be revised and updated as more information becomes available. The following sections provide descriptions of how the effects matrix is organized, how the matrix is used, and the final effects determinations matrix, which displays the effects of COP activities on coastal habitats and incorporates the assumptions listed above. For this white paper, cumulative impacts were not included in the scope of work. Additional information on cumulative impacts, additional COPs, or additional habitats could be added and included in the effects determination in the future as BOEM issues NEPA decision documents.

6.1.1 Organization of Matrix

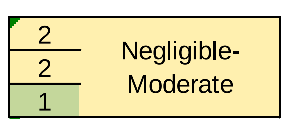
The COP effects matrix is based on a series of tables that provide a user the opportunity to enter information about the particular effect of a COP activity on a given habitat within the context of one of three evaluation metrics: intensity, context, or duration. The information provided by the user is compiled and presented in a final matrix of effects. The user can change or “scale” the effects depending on the project. The matrix can be edited to change habitat complexes, COP activities, and COP effects. Additionally, the matrix accommodates updates of future effects determinations resulting from OSW facilities that have been analyzed and adopted by BOEM in a FONSI or a ROD for incorporation by reference. As discussed elsewhere in this document, the identification of COP activities that may affect coastal habitats was based largely on the Rhode Island Block Island project, which is currently the only OSW facility presently permitted and under construction in the U.S. The Block Island OSW facility is a good proxy to use as it represents the likely scenario for other planned OSW facilities, such as the VOWTAP and Massachusetts Cape Wind project (originally approved for 3.6 MW turbines but it is unlikely these smaller turbines will be installed given current wind energy technology). Steps required to develop the COP effects matrix included the following:

1. Identify coastal habitats located along the U.S. Atlantic coast (described in Chapter 3). Within the matrix, these have been further narrowed by grouping similar habitats into habitat complexes.
2. List the COPs that may affect identified coastal habitats (Chapter 4).
3. Develop a list of effects resulting from COPs that could affect the coastal habitats (Chapter 5).

4. Apply information from existing NEPA documents and best available science to complete an effects matrix of potential effects from COP activities by habitat complex, with additional divisions to address differences in impact by ICD.
5. Compile information on COP activities across all habitat complexes into a matrix that integrates intensity, context, and duration into an ICD value for each combination of activity and habitat, displaying the overall ICD value as well as individual intensity, context, and duration rankings.
6. Set up basic protection measures for formulas and hidden tabs throughout the workbook.
7. Develop a set of instructions for using the COP effects matrix

As described earlier, the matrix relies on user-entered, project-specific data. The user simply enters ranks for intensity, context, and duration for each effect of a COP activity in the tabs of a Microsoft Excel™ workbook for each habitat complex. The data are carried through to a final display matrix that presents the overall range (e.g., negligible to minor) of effects of each activity for each habitat complex in the center of the cell, with the individual rankings for intensity, context, and duration along the left side of the cell to indicate the source of the range in rankings. In addition to the values presented on the display tab, labels that appear on the habitat complex and display tabs are linked by formulas to tabs initially hidden to the user. Both cells with formulas and hidden tabs have been password protected and users wishing to make edits beyond specific evaluation metric rankings will need to request this password. There are five types of tabs in the workbook:

- READ.ME tab: Instructions on use of the matrix
- DISPLAY tab: Contains the final matrix, which presents a summary of all the information provided across habitat complexes. All values shown on the DISPLAY tab are linked through a series of look-up tables to data that have been entered on habitat complex tabs. Overall effects determinations are shown as a range. For example, "minor to moderate" displayed in the center of each cell, with individual rankings for intensity, context, and duration in subcells so that information remains "in context" (Table 6-5). The maximum ICD value is carried through from hidden tabs discussed below. The cells are color-coded based on the mode of the ICD values (e.g., 0-0-2 is blue, 0-2-2 is yellow), except where there is no mode (e.g., 1-2-3), in which case the color is represented by the maximum ICD value so that, in the example of ICD values of "1-2-3," the cell would be red. Colors range from blue (negligible) to red (major impact). Because the DISPLAY tab has been designed to accommodate 10 habitat complexes and 10 COP activity groups of 10 activities each, a filter has been provided in the far-right column whereby a user can remove from view any unused rows. Unused columns can be hidden by selecting the columns, right-clicking on one of the selected columns, and choosing "Hide" from the pop-up menu. In the example cell below, the effect of an activity on a habitat is "negligible to moderate." To the left of the effect, rankings for intensity (2), context (2), and duration (1) display the range of rankings.



- Habitat Complex tabs: Five tabs are provided that reflect habitat complexes developed for this project. An additional five habitat complex tabs have been provided, but are initially hidden to the user. Habitat complex tabs are divided into three sections based on the evaluation metrics listed at the top of each tab. Clicking on the evaluation metric will navigate the user to a particular section on that tab. Because the habitat complex tabs have been designed to accommodate 10 COP activity groups of 10 activities each, a filter has been provided in the far-right column whereby a user can remove from view any unused rows.

- References tabs: Two tabs contain the sources used to develop the relative impact values entered into the habitat complex tabs. NEPA documents are separated from scientific literature because the organization of information related to these sources is different. At this stage, the references listed on the DISPLAY tab for each COP activity group refer only to NEPA references.
- Labeling tabs: Three tabs, ACTIVITIES, HABITATS, and RANKINGS, are hidden when the user first opens the workbook. These tabs set the headings of the workbook and allow the user to edit the names and number of habitats and COP activities examined in the DISPLAY tab. They provide the following functionality to the workbook:
  - ACTIVITIES tab: under the ACT_DESC and ACT_GRP columns users can alter the COP activity or COP activity group descriptions, respectively, to edit, add, or remove activities from the habitat complex and DISPLAY tabs. See the READ.ME tab in the COP effects matrix for specific instructions.
  - HABITATS tab: A series of three tables. The top-left table shows the habitats that have been assigned to specific habitat complexes (Table 6-1). The top-right table lists the habitat complexes. Here, habitat complexes can be altered to edit, add, or remove habitat complexes. See the READ.ME tab in the COP effects matrix for specific instructions.
  - RANKINGS Tab: List of rankings and explanations.
- Evaluation metric tabs (Intensity, Context, and Duration): Compile data on the respective evaluation matrix from across the habitat complex tabs (visible and hidden) and reorganize the information for the formulas that run the DISPLAY tab.

Table 6-1. Coastal Habitats and Habitat Complexes

Habitat	Habitat Complex
Coastal Uplands	Coastal Uplands
Dunes	Beaches and Dunes
Beaches	Beaches and Dunes
Tidal Flats	Tidal flats and Rocky Intertidal Zones
Rocky Intertidal Zones	Tidal flats and Rocky Intertidal Zones
Salt/Brackish Wetlands	Marshes
Submerged Aquatic Vegetation	Submersed
Shellfish Reefs	Submersed
Coral Reefs	Submersed
Nearshore Soft Bottom	Submersed
Water Column	Submersed

Table 6-2. List of COP Activities that May Affect Coastal Habitats

Onshore Construction	
1	Substation and switchyard construction
2	Install overhead cable and taller utility poles
3	Install cables and trench excavation
4	Install onshore cable right-of-way construction
5	Install onshore vehicle use and travel
Landfall Construction	
6	Cable trench excavation and jet plow
7	Landfall HDD short and long distance
Offshore Construction	
8	Cable array at WTGs installation
9	Export cable to shore installation
10	Substation installation
11	Offshore foundation installation
12	Offshore pile driving
13	Temporary cofferdam for long dist. HDD
14	Barge and tug WTG transportation
15	WTG installation 5 weeks/WTG
16	Crew boat travel
Operation And Maintenance	
17	Maintenance 3-5 days/year/WTG
18	ROV inspections at 5 year intervals
19	Subbottom profiles at 5 year intervals
20	Substation right-of-way maintenance
21	On and off shore environmental monitoring
Decommissioning	
22	Foundation and WTG removal
23	Offshore cable abandonment
24	Demobilization

Table 6-3. List of Effects (from COPs) that May Affect Coastal Habitats

Effects (from COPs)
Sediment disturbance due to construction, operation, and cable installation
Erosion due to vessel activities
Clearing for right-of-way
Direct habitat removal/loss for facilities
Invasive/ nonnative species introduction and/or expansion
Contamination due to spills

As an example, values in Table 6-4 reflect the relative intensity impacts from COP actions affecting the submersed habitat complex. The effects matrix includes definitions used for intensity, context, and duration, outlined below, used in the evaluations.

• **Intensity**	Relative difficulty of recovery:	3 = Severe	2 = Moderate	1 = Minor	0 = None
• **Context**	Relative area impacted:	3 = All areas	2 = Most areas	1 = Localized	0 = None
• **Duration**	Relative amount of time:	3 = Permanent	2 = Long-term	1 = Short-term	0 = None

Table 6-4. An Example of How Information Is Presented in a Habitat Complex Tab. Values have been entered on the relative intensity of effects on a project from COP activities affecting submersed habitats.

Construction and Operation Plan Actions	**Sediment disturbance**	**Erosion**	**Clearing**	**Removal**	**Invasive/ non-native species**	**Contamination**	**Maximum Rank**
ONSHORE CONSTRUCTION							
Substation and switchyard construction	0	2	0	0	1	2	**2**
Install overhead cable and taller utility poles	0	2	0	0	1	2	**2**
Install cables and trench excavation	0	2	0	0	1	2	**2**
Install onshore cable right-of-way construction	0	2	0	0	1	2	**2**
Install onshore vehicle use and travel	0	2	0	0	1	2	**2**
LANDFALL CONSTRUCTION							
Cable trench excavation and jet plow	0	1	0	0	1	1	**1**
Landfall HDD short and long distance	0	1	0	0	1	1	**1**
OFFSHORE CONSTRUCTION							
Cable array at WTGs installation	1	1	0	0	0	0	**1**
Export cable to shore installation	1	1	0	0	0	0	**1**
Substation installation	1	1	0	0	0	0	**1**
Offshore foundation installation	1	1	0	0	0	0	**1**
Offshore pile driving	1	1	0	0	0	0	**1**
Temporary cofferdam for long dist. HDD	1	1	0	0	0	0	**1**
Barge and tug WTG transportation	1	1	0	0	0	1	**1**
WTG installation 5 weeks/WTG	1	1	0	0	0	1	**1**
Crew boat travel	1	1	0	0	0	1	**1**
OPERATION AND MAINTENANCE							
Maintenance 3–5 days/year/WTG	1	1	0	0	0	1	**1**
ROV inspections at 5-year intervals	0	0	0	0	0	1	**1**
Sub-bottom profiles at 5-year intervals	1	0	0	0	0	1	**1**

Construction and Operation Plan Actions	Sediment disturbance	Erosion	Clearing	Removal	Invasive/ non-native species	Contamination	Maximum Rank
Substation right-of-way maintenance	1	1	0	0	0	1	**1**
On and off shore environmental monitoring	0	0	0	0	0	0	**0**
DECOMMISSIONING							
Foundation and WTG removal	1	1	1	1	1	1	**1**
Offshore cable abandonment	1	1	1	1	0	1	**1**
Demobilization	0	0	0	0	0	0	**0**

Table 6-5. Effects Determination Matrix with Values Reflected through Related Tables that Describe Potential Impacts on Each Habitat Complex for Intensity, Context, and Duration

Matrix of COP Activities and Potential Habitat Impacts

Links to the references that support the values in the table are provided at the end of each COP activity category.

Click on the COP activity category to move to its place in the matrix.

- ONSHORE CONSTRUCTION
- LANDFALL CONSTRUCTION
- OFFSHORE CONSTRUCTION
- OPERATION AND MAINTENANCE
- DECOMMISSIONING

(Click on the habitat complex heading to link to tables that correspond to its intensity, context, and duration.)

Activity / Habitat		Coastal Uplands		Beaches & Dunes		Tidal flats & Rocky Intertidal		Marshes		Submersed Habitats	
ONSHORE CONSTRUCTION											
Substation and switchyard construction	I	3		2		2		2		2	
	C	3	Major	2	Moderate	2	Moderate	2	Moderate	2	Moderate
	D	3		2		2		2		2	
Install overhead cable and taller utility poles	I	2		2		2		2		2	
	C	2	Moderate-Major	2	Moderate	2	Moderate	2	Moderate	2	Moderate
	D	3		2		2		2		2	
Install cables and trench excavation	I	3		2		2		2		2	
	C	3	Major	2	Moderate	2	Minor-Moderate	2	Minor-Moderate	2	Moderate
	D	3		2		1		1		2	
Install onshore cable ROW construction	I	2		2		2		2		2	
	C	2	Moderate	2	Moderate	2	Minor-Moderate	2	Minor-Moderate	2	Moderate
	D	2		2		1		1		2	
Install onshore vehicle use and travel	I	2		2		2		2		2	
	C	2	Minor-Moderate	2	Minor-Moderate	2	Minor-Moderate	2	Minor-Moderate	2	Moderate
	D	1		1		1		1		2	
References No.		*1, 5, 6, 14, 16*									
LANDFALL CONSTRUCTION											
Cable trench excavation and jet plow	I	2		2		2		2		2	
	C	1	Minor-Moderate	2	Minor-Moderate	2	Minor-Moderate	2	Minor-Moderate	2	Minor-Moderate
	D	1		1		1		1		1	
Landfall HDD short and long distance	I	1		2		2		2		2	
	C	1	Minor	2	Minor-Moderate	2	Minor-Moderate	2	Minor-Moderate	2	Minor-Moderate
	D	1		1		1		1		1	
References No.		*5, 6, 11, 14, 15, 16*									
OFFSHORE CONSTRUCTION											
Cable array at VTGs installation	I	0		0		0		0		1	
	C	0	Negligible	0	Negligible	0	Negligible	0	Negligible	1	Minor
	D	0		0		0		0		1	
Export cable to shore installation	I	0		0		0		0		1	
	C	0	Negligible	0	Negligible	0	Negligible	0	Negligible	1	Minor
	D	0		0		0		0		1	
Substation installation	I	0		0		0		0		1	
	C	0	Negligible	0	Negligible	0	Negligible	0	Negligible	1	Minor
	D	0		0		0		0		1	
Offshore foundation installation	I	0		0		0		0		1	
	C	0	Negligible	0	Negligible	0	Negligible	0	Negligible	1	Minor
	D	0		0		0		0		1	
Offshore pile driving	I	0		0		0		0		1	
	C	0	Negligible	0	Negligible	0	Negligible	0	Negligible	1	Minor
	D	0		0		0		0		1	
Temporary cofferdam for long dist. HDD	I	0		0		0		0		1	
	C	0	Negligible	0	Negligible	0	Negligible	0	Negligible	1	Minor
	D	0		0		0		0		1	
Barge and tug VTG transportation	I	0		1		1		2		1	
	C	0	Negligible	0	Negligible-Minor	1	Minor-Moderate	1	Minor-Moderate	1	Minor
	D	0		0		2		2		1	
VTG installation 5 weeks/VTG	I	0		1		1		2		1	
	C	0	Negligible	0	Negligible-Minor	1	Minor-Moderate	1	Minor-Moderate	1	Minor
	D	0		0		2		2		1	
Crew boat travel	I	0		1		1		2		1	
	C	0	Negligible	0	Negligible-Minor	1	Minor-Moderate	1	Minor-Moderate	1	Minor
	D	0		0		2		2		1	

6.2 Matrix of Effects Determination

The final matrix is based on an analysis of COP activities effects on each habitat, each addressing intensity, context, and duration. Effects of each potential COP activity were evaluated with respect to intensity, context, and duration, using rankings of negligible impact (0), minor adverse impact (1), moderate adverse impact (2), and major adverse impact (3). These rankings were summarized into the maximum ranking for each combination of COP action and habitat complex.

The NEPA regulations require a level of significance for effects determinations that is based on the twin criteria of context and intensity. "Significantly" as used in NEPA requires considerations of both context and intensity. Duration was added due to the importance of long and short-term impacts. Each of these is defined below.

(a) Intensity. This refers to the severity of impact. Responsible officials must bear in mind that more than one agency may make decisions about partial aspects of a major action. (Ability of resource to recover following loss/disturbance was also considered for this paper.) The following should be considered in evaluating intensity:

1. The degree to which the possible effects on the human environment are highly uncertain or involve unique or unknown risks.
2. The degree to which the action may adversely affect an endangered or threatened species or its habitat that has been determined to be critical under the Endangered Species Act of 1973.

(b) Context. This means that the significance of an action must be analyzed in several contexts such as society as a whole (human, national), the affected region, the affected interests, and the locality. Significance varies with the setting of the proposed action. For instance, in the case of a site-specific action, significance would usually depend upon the effects in the locale rather than in the world as a whole. Both short- and long-term effects are relevant. (Rarity of habitat was also a consideration for this paper.)

(c) Duration. This was added to the determinations for this white paper and considers the impacts of effects as permanent, long term, and short term. Short-term effects are defined as lasting less than two growing seasons and long-term effects as lasting longer than two growing seasons.

Thresholds of impacts for context, intensity, and duration were ranked for each habitat complex. The MMS FPEIS (MMS 2007a) for Alternative Energy on the OCS defines these thresholds for minor, moderate, and major impacts, as outlined below, with examples.

- (0) Negligible impact (no measurable impact)
- (1) Minor—should not influence or have only small impacts on the affected resource, activity, or community. For example, impacts on native vegetation may be detectable, but could not alter natural conditions and be limited to localized areas.
- (2) Moderate—impacts could moderately influence the resource, activity, or community, generally or for particular species. For example, impacts on native vegetation could be measurable but limited to local and adjacent areas. Occasional disturbance to individual plants could be expected. These disturbances could affect local populations negatively, but could not be expected to affect regional population stability.

- (3) Major—impacts could significantly influence the resource, activity, or community, generally or for particular species. For example, impacts on native vegetation could be measurable and wide-spread. Frequent disturbances of individual plants could be expected, with negative impacts on both local and regional population levels. These disturbances could negatively affect range-wide population stability.

For example, the effects of substation and switchyard construction (first line in list of COPs, Table 6-2) on each of the six effects (Table 6-3) were ranked (from 0 to 3) for intensity, context, and intensity, for each habitat complex (Table 6-1).

An example of an evaluation of COPs on the submersed habitat complex is provided in Table 6-4. An example of the overall matrix generated from the ICD values for each habitat is provided in Table 6-5.

Impacts of proximate port and other associated development were also included in the effects determination. Impacts on coastal habitats are anticipated as a result of modification and/or expansion of an existing port facility (new facilities are not addressed). Impacts are expected to be minor to major, depending on whether the existing footprint is expanded or not. Impacts are expected to be associated with continued or increased channel dredging for additional vessel traffic, additional cable installation, and additional traffic associated with port to OSW facility for operation and maintenance. Erosion and minor reductions in habitat during construction are anticipated to have relatively minor impacts on shoreline habitats.

6.3 Instructions for Updating the Effects Determination Matrix

The HABITATS, ACTIVITIES, RANKINGS, and habitat complex tabs may all be changed to reflect project details or changes in available information. For this project, 5 of the 10 available habitat complex tabs were filled utilizing 5 (of 10) available COP activity groups that describe 24 (of 100) COP activities. Row filters provided in the right-most column of the DISPLAY tab and habitat complex tabs allow users to show only the COP activities and activity groups being used for a given project. See the READ.ME tab for specific editing instructions. The remaining tabs self-generate. One could change the habitats, the COPs, and the rankings for intensity, context, and duration, as described earlier in Section 6.1.1.

The mapping data layers compiled for this white paper provide a means of determining whether a given habitat is likely to be affected and how sensitive or other areas can be avoided. Avoidance results in a rank of 0 (negligible impact) in any of the matrix tabs.

Finally, with respect to OSW facility scale, impacts on coastal habitats are typically localized and associated with (or within) an existing right-of-way. The most "significant" scaling-up would likely be due to an expansion of the footprint of the onshore facility and transmission right-of-way and can easily be incorporated in the HAB X ACTION X ICD tabs and then self-generated through to the final matrix in the DISPLAY tab. Scaling up and down would also increase/decrease the vessel activity effects on shorelines and changes to tabs can also be made to reflect these differences.

Chapter 7
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Appendix A: Data Resources

The data compiled for this white paper are intended to provide broad set of resources for assessing the coastal habitats described within this section. Coverage areas by planning area or across the entire Atlantic BOEM planning region can be viewed in Chapter 3, Figures 3-1 to 3-5. The labels of figures in Chapter 3 corresponds to the labelled tables in this appendix so that Table A-1 reflects data covering the area shown in Figure 3-1, Table A-2 corresponds to Figure 3-2, and so on. In order to be considered for inclusion, data needed to be publicly accessible and, as a general rule, mapped to at least the state-level. Where smaller-scale data sets offered a more current resource or were the sole source for a particular habitat within a state, these data were included. Large-scale national and regional efforts provided important sources for many of the habitats and these included datasets published by NOAA, USFWS, USGS, and The Nature Conservancy, and included ESI atlases, the National Wetlands Inventory, National Gap Analysis Program Land Cover Data- Version 2, and data products from the Northwest Atlantic Marine Ecoregional Assessment.

The ESI atlases, in particular, were considered a valuable data resource from New Hampshire to Georgia, given the release of updates to these states began in 2014, and are expected to be completed with all data made publicly accessible by early 2017. In many cases, the links to datasets provided in Tables A-1 through A-5 will require the user to further specify a particular dataset or region, rather than link to the specific page for downloading the data. This was done so that users may observe where more recent data may have been published since the time of writing. Additionally, many of the datasets listed below may be accessed or downloaded from regional geographic information system interactive map portals and data catalogs. However, these portals may not be as current as the data provided by the publisher and so have been excluded from this effort.

Table A-1. Data sources with coverage of all Atlantic BOEM Planning Areas. Publicly available geospatial data for mapping coastal, intertidal, and nearshore marine habitats. Details for each dataset include its title, brief description of what the data includes, comments for appropriate application, data format (shapefile, shp; geodatabase, gdb; keyhole markup language zipped, kmz), the organization hosting the data, data or most recent data, and a link to where the data may be downloaded.

Habitat	Data Resource
COASTAL UPLANDS	**Coverage:** Entire Area — Online Location **Title:** *National Gap Analysis Program Land Cover Data- Version 2* **Host:** USGS **Year:** 2015 **Format:** gdb **Description:** Land cover data able with globally ranked habitat classifications. **Comment:** Global rankings for habitats are available through NatureServe.
COASTAL UPLANDS	**Coverage:** Entire Area — Online Location **Title:** *Ecoregions Level III and IV* **Host:** USEPA **Year:** 2013 **Format:** gdb **Description:** Ecoregions denote areas of general similarity in ecosystems and in the type, quality, and quantity of environmental resources. **Comment:** General descriptions for each ecoregion can be found through USEPA's website or NatureServe.
DUNES	**Coverage:** Entire Area — Online Location **Title:** *National Gap Analysis Program Land Cover Data- Version 2* **Host:** USGS **Year:** 2015 **Format:** gdb **Description:** Land cover data able with globally ranked habitat classifications. **Comment:** Global rankings for habitats are available through NatureServe.
ROCKY INTERTIDAL ZONES	**Coverage:** Entire Area — Online Location **Title:** *National Wetlands Inventory (NWI)* **Host:** USGS **Year:** 2016 **Format:** gdb/ shp **Description:** Rocky Shore Intertidal Wetlands **Comment:** NWI classifications beginning with M2RS which includes bedrock (M2RS1) and rubble (M2RS2). See NWI classification scheme.
SALT/BRACKISH WETLANDS	**Coverage:** Entire Area — Online Location **Title:** *National Gap Analysis Program Land Cover Data- Version 2* **Host:** USGS **Year:** 2015 **Format:** gdb **Description:** Land cover data able with globally ranked habitat classifications. **Comment:** Global rankings for habitats are available through NatureServe.
SALT/BRACKISH WETLANDS	**Coverage:** Entire Area — Online Location **Title:** *National Wetlands Inventory* **Host:** USGS **Year:** 2016 **Format:** gdb/ shp **Description:** Nationwide salt, brackish, and freshwater wetlands. **Comment:** N/A

Habitat	Data Resource
TIDAL FRESHWATER WETLANDS	**Coverage:** Entire Area [Online Location] **Title:** *National Gap Analysis Program Land Cover Data- Version 2* **Host:** USGS **Year:** 2015 **Format:** gdb **Description:** Land cover data able with globally ranked habitat classifications. **Comment:** Global rankings for habitats are available through NatureServe.
TIDAL FRESHWATER WETLANDS	**Coverage:** Entire Area [Online Location] **Title:** *National Wetlands Inventory* **Host:** USGS **Year:** 2016 **Format:** gdb/ shp **Description:** Nationwide salt, brackish, and freshwater wetlands. **Comment:** N/A
DEVELOPED AREAS/RIGHTS-OF-WAY	**Coverage:** Entire Area [Online Location] **Title:** *National Land Cover Database (NLCD) 2011 Percent Developed Imperviousness* **Host:** MRLC **Year:** 2011 **Format:** gdb **Description:** Developed areas interpreted by percentage of impervious surfaces, which includes materials such as pavement, asphalt, and concrete. **Comment:** N/A
NEARSHORE HARD BOTTOM	**Coverage:** Entire Area [Online Location] **Title:** *Unified Florida Reef Tract Map* **Host:** FWRI **Year:** 2015 **Format:** gdb **Description:** The Unified Florida Reef Tract Map (Unified Reef Map) provides a consistent geospatial framework for management, monitoring, and characterization of the Florida reef tract from Martin County to the Dry Tortugas. The Unified Reef Map integrates existing benthic habitat maps of Martin, Palm Beach, Broward, and Miami Counties, Biscayne National Park, Florida Bay, and the Florida Keys, including the Dry Tortugas. **Comment:** Several different types are in this shapefile, including aggregate reef, patch reef, and pavement
NEARSHORE HARD BOTTOM	**Coverage:** Entire Area [Online Location] **Title:** *Worm reef habitats, Florida East Coast* **Host:** FWRI/TNC **Year:** 2004 **Format:** shp **Description:** This GIS data set represents known locations of annelid worm reefs. It is not a comprehensive mapping effort. The Nature Conservancy created a worm reef shapefile, containing the locations of annelid worm reefs (Phragmaopoma lapidosa) on Florida's east coast as identified from available literature and location information obtained from worm reef experts in Florida. **Comment:** N/A

Habitat	Data Resource					
NEARSHORE SOFT BOTTOM	**Coverage:**	Entire Area			Online Location	
	Title:	*Unified Florida Reef Tract Map*				
	Host:	FWRI	**Year:**	2015	**Format:**	gdb
	Description:	The Unified Florida Reef Tract Map (Unified Reef Map) provides a consistent geospatial framework for management, monitoring, and characterization of the Florida reef tract from Martin County to the Dry Tortugas. The Unified Reef Map integrates existing benthic habitat maps of Martin, Palm Beach, Broward, and Miami Counties, Biscayne National Park, Florida Bay, and the Florida Keys, including the Dry Tortugas.				
	Comment:	Habitat can be identified in the ClassLv field by ClassLv2='Unconsolidated sediment'				
SUBMERGED AQUATIC VEGETATION	**Coverage:**	Entire Area			Online Location	
	Title:	*Unified Florida Reef Tract Map*				
	Host:	FWRI	**Year:**	2015	**Format:**	gdb
	Description:	The Unified Florida Reef Tract Map (Unified Reef Map) provides a consistent geospatial framework for management, monitoring, and characterization of the Florida reef tract from Martin County to the Dry Tortugas. The Unified Reef Map integrates existing benthic habitat maps of Martin, Palm Beach, Broward, and Miami Counties, Biscayne National Park, Florida Bay, and the Florida Keys, including the Dry Tortugas.				
	Comment:	Habitat can be identified in the ClassLv field by ClassLv0 = 'Seagrass'				
SUBMERGED AQUATIC VEGETATION	**Coverage:**	Entire Area			Online Location	
	Title:	*Indian River lagoon seagrass data*				
	Host:	SJRWMD	**Year:**	2015	**Format:**	shp
	Description:	2015 seagrass survey data for the Indian River Lagoon				
	Comment:	N/A				
SUBMERGED AQUATIC VEGETATION	**Coverage:**	Entire Area			Online Location	
	Title:	*Loxahatchee seagrass, 2004*				
	Host:	SFWMD	**Year:**	2004	**Format:**	shp
	Description:	The purpose of this project is to monitor seagrasses within the Central Embayment of the Loxahatchee River. Performing trend analysis by continued mapping of this area will allow district personnel to track the health of the seagrass communities.				
	Comment:	N/A				

Habitat	Data Resource	
TIDAL FLATS	**Coverage:**	Entire Area Online Location
	Title:	*Unified Florida Reef Tract Map*
	Host:	FWRI **Year:** 2015 **Format:** gdb
	Description:	The Unified Florida Reef Tract Map (Unified Reef Map) provides a consistent geospatial framework for management, monitoring, and characterization of the Florida reef tract from Martin County to the Dry Tortugas. The Unified Reef Map integrates existing benthic habitat maps of Martin, Palm Beach, Broward, and Miami Counties, Biscayne National Park, Florida Bay, and the Florida Keys, including the Dry Tortugas.
	Comment:	Habitat can be identified in the ClassLv field by ClassLv2 = 'Tidal Flats'

Table A-2. Data sources with coverage of the North Atlantic Planning Area. Publicly available geospatial data for mapping coastal, intertidal, and nearshore marine habitats. Details for each dataset include its title, brief description of what the data includes, comments for appropriate application, data format (shapefile, shp; geodatabase, gdb; keyhole markup language zipped, kmz), the organization hosting the data, the currentness of the data, and a link to where the data may be downloaded.

Habitat	Data Resource
COASTAL UPLANDS	**Coverage:** ME — Online Location **Title:** *Northeast Terrestrial Habitat Mapping Project* **Host:** TNC **Year:** 2011 **Format:** .tif **Description:** Terrestrial habitats from Maine to Virginia classified based on NatureServe's Ecological Systems Classification. **Comment:** N/A
COASTAL UPLANDS	**Coverage:** NH — Online Location **Title:** *Natural Heritage Bureau Database* **Host:** NH GRANIT **Year:** 2016 **Format:** shp **Description:** Locations of rare and declining plant and animal species and exemplary natural communities. **Comment:** Data must be requested from the NH Natural Heritage Bureau, Department of Resources and Economic Development. Data is updated bi-annually.
COASTAL UPLANDS	**Coverage:** MA — Online Location **Title:** *BioMap2* **Host:** MassGIS **Year:** 2011 **Format:** shp **Description:** Core Habitat (CH) identifies specific areas necessary to promote the long-term persistence of Species of Conservation Concern, exemplary natural communities, and intact ecosystems **Comment:** N/A
COASTAL UPLANDS	**Coverage:** MA — Online Location **Title:** *Natural Heritage & Endangered Species Program (NHESP) Natural Communities* **Host:** MassGIS **Year:** 2016 **Format:** shp **Description:** Polygons that represent the extent of various natural communities of biodiversity conservation interest in Massachusetts. **Comment:** From 97 community types, 73 are Priority for conservation (ranked S1 through S3S4) and 24 types are more common or Low-priority for conservation (S4 and S5).
COASTAL UPLANDS	**Coverage:** NY — Online Location **Title:** *Significant Natural Community Occurrences* **Host:** NYSDEC-NHP **Year:** 2013 **Format:** kmz **Description:** Features represent element occurrences of significant natural communities (ecological communities), as recorded by the New York Natural Heritage Program. **Comment:** N/A

Habitat	Data Resource
DUNES	**Coverage:** ME [Online Location] **Title:** *Northeast Terrestrial Habitat Mapping Project* **Host:** TNC **Year:** 2011 **Format:** .tif **Description:** Terrestrial habitats from Maine to Virginia classified based on NatureServe's Ecological Systems Classification. **Comment:** N/A
DUNES	**Coverage:** MA [Online Location] **Title:** *Natural Heritage & Endangered Species Program (NHESP) Natural Communities* **Host:** MassGIS **Year:** 2016 **Format:** shp **Description:** Polygons that represent the extent of various natural communities of biodiversity conservation interest in Massachusetts. **Comment:** From 97 community types, 73 are Priority for conservation (ranked S1 through S3S4) and 24 types are more common or Low-priority for conservation (S4 and S5).
DUNES	**Coverage:** NY [Online Location] **Title:** *Significant Natural Community Occurrences* **Host:** NYSDEC-NHP **Year:** 2013 **Format:** kmz **Description:** Features represent element occurrences of significant natural communities (ecological communities), as recorded by the New York Natural Heritage Program. **Comment:** N/A
BEACHES	**Coverage:** ME [Online Location] **Title:** *Environmental Vulnerability Index (EVI) Maps* **Host:** OR&R, NOAA **Year:** 2007 **Format:** .gdb **Description:** Linear extents of beaches. **Comment:** These habitats are shown as polygons included in the ESI LINES feature class.
BEACHES	**Coverage:** NH [Online Location] **Title:** *New Hampshire Environmental Sensitivity Index Atlas* **Host:** OR&R, NOAA **Year:** 2004 **Format:** .gdb **Description:** Linear extents of beaches. **Comment:** These habitats are included as part of the ESI LINES feature. These data are expected to be updated within the next year, though the download link should remain the same.
BEACHES	**Coverage:** MA [Online Location] **Title:** *Massachusetts Environmental Sensitivity Index Atlas* **Host:** OR&R, NOAA **Year:** 1999 **Format:** .gdb **Description:** Linear extents of beaches. **Comment:** These habitats are included as part of the ESI LINES feature. These data are expected to be updated within the next year, though the download link should remain the same.

Habitat	Data Resource
BEACHES	**Coverage:** MA — Online Location **Title:** *Marine Beaches* **Host:** MassGIS **Year:** 2003 **Format:** shp **Description:** Feature class representing the linear extents of Massachusetts' beaches. **Comment:** Derived from orthographic imagery by the Massachusetts Department of Public Health (MDPH), Center for Environmental Health (CEH), Environmental Toxicology Program (ETP).
BEACHES	**Coverage:** MA — Online Location **Title:** *BioMap2* **Host:** MassGIS **Year:** 2011 **Format:** shp **Description:** Core Habitat (CH) identifies specific areas necessary to promote the long-term persistence of Species of Conservation Concern (those listed under the Massachusetts Endangered Species Act as well as additional species identified in the State Wildlife Action Plan), exemplary natural communities, and intact ecosystems **Comment:** N/A
BEACHES	**Coverage:** MA — Online Location **Title:** *Natural Heritage & Endangered Species Program (NHESP) Natural Communities* **Host:** MassGIS **Year:** 2016 **Format:** shp **Description:** Polygons that represent the extent of various natural communities of biodiversity conservation interest in Massachusetts. **Comment:** From 97 community types, 73 are Priority for conservation (ranked S1 through S3S4) and 24 types are more common or Low-priority for conservation (S4 and S5).
BEACHES	**Coverage:** RI, CT, NY, NJ — Online Location **Title:** *Rhode Island, Connecticut, and New York-New Jersey Metropolitan Area Environmental Sensitivity Index Atlas* **Host:** OR&R, NOAA **Year:** 2001 **Format:** .gdb **Description:** Linear extents of beaches. **Comment:** These habitats are included as part of the ESI LINES feature. These data are expected to be updated within the next year, though the download link should remain the same.
BEACHES	**Coverage:** CT, NY — Online Location **Title:** *Long Island Sound Environmental Sensitivity Index Atlas* **Host:** OR&R, NOAA **Year:** 2016 **Format:** .gdb **Description:** Linear extents of beaches. **Comment:** These habitats are included as part of the ESI LINES feature.
BEACHES	**Coverage:** NY, NJ — Online Location **Title:** *New York and New Jersey Environmental Sensitivity Index Atlas* **Host:** OR&R, NOAA **Year:** 2016 **Format:** .gdb **Description:** Linear extents of beaches. **Comment:** These habitats are included as part of the ESI LINES feature.

Habitat	Data Resource
BEACHES	**Coverage:** NJ [Online Location] **Title:** *Delaware, New Jersey, and Pennsylvania Environmental Sensitivity Index Atlas* **Host:** OR&R, NOAA **Year:** 2014 **Format:** .gdb **Description:** Linear extents of beaches. **Comment:** These habitats are shown as polygons included in the ESI POLYS feature class.
TIDAL FLATS	**Coverage:** ME [Online Location] **Title:** *Environmental Vulnerability Index (EVI) Maps* **Host:** OR&R, NOAA **Year:** 2007 **Format:** .gdb **Description:** Exposed and sheltered sand and mud tidal flats. **Comment:** These habitats are included as part of the ESI POLYS feature.
TIDAL FLATS	**Coverage:** NH [Online Location] **Title:** *New Hampshire Environmental Sensitivity Index Atlas* **Host:** OR&R, NOAA **Year:** 2004 **Format:** .gdb **Description:** Exposed and sheltered sand and mud tidal flats. **Comment:** These habitats are included as part of the ESI POLYS feature. These data are expected to be updated within the next year, though the download link should remain the same.
TIDAL FLATS	**Coverage:** MA [Online Location] **Title:** *Massachusetts Environmental Sensitivity Index Atlas* **Host:** OR&R, NOAA **Year:** 1999 **Format:** .gdb **Description:** Exposed and sheltered sand and mud tidal flats. **Comment:** These habitats are included as part of the ESI POLYS feature. These data are expected to be updated within the next year, though the download link should remain the same.
TIDAL FLATS	**Coverage:** MA [Online Location] **Title:** *BioMap2* **Host:** MassGIS **Year:** 2011 **Format:** shp **Description:** Core Habitat (CH) identifies specific areas necessary to promote the long-term persistence of Species of Conservation Concern (those listed under the Massachusetts Endangered Species Act as well as additional species identified in the State Wildlife Action Plan), exemplary natural communities, and intact ecosystems **Comment:** N/A
TIDAL FLATS	**Coverage:** MA [Online Location] **Title:** *Natural Heritage & Endangered Species Program (NHESP) Natural Communities* **Host:** MassGIS **Year:** 2016 **Format:** shp **Description:** Polygons that represent the extent of various natural communities of biodiversity conservation interest in Massachusetts. **Comment:** From 97 community types, 73 are Priority for conservation (ranked S1 through S3S4) and 24 types are more common or Low-priority for conservation (S4 and S5).

Habitat	Data Resource
TIDAL FLATS	**Coverage:** MA — Online Location **Title:** *Intertidal Flats* **Host:** MORIS **Year:** 2015 **Format:** shp **Description:** Polygons representing intertidal flats. **Comment:** Desired data layer can be reviewed in the viewer, and then downloaded.
TIDAL FLATS	**Coverage:** RI, CT, NY, NJ — Online Location **Title:** *Rhode Island, Connecticut, and New York-New Jersey Metropolitan Area Environmental Sensitivity Index Atlas* **Host:** OR&R, NOAA **Year:** 2001 **Format:** .gdb **Description:** Exposed and sheltered sand and mud tidal flats. **Comment:** These habitats are included as part of the ESI POLYS feature. These data are expected to be updated within the next year, though the download link should remain the same.
TIDAL FLATS	**Coverage:** CT, NY — Online Location **Title:** *Long Island Sound Environmental Sensitivity Index Atlas* **Host:** OR&R, NOAA **Year:** 2016 **Format:** .gdb **Description:** Exposed and sheltered sand and mud tidal flats. **Comment:** These habitats are included as part of the ESI POLYS feature.
TIDAL FLATS	**Coverage:** NY, NJ — Online Location **Title:** *New York and New Jersey Environmental Sensitivity Index Atlas* **Host:** OR&R, NOAA **Year:** 2016 **Format:** .gdb **Description:** Exposed and sheltered sand and mud tidal flats. **Comment:** These habitats are included as part of the ESI POLYS feature.
TIDAL FLATS	**Coverage:** NJ — Online Location **Title:** *Delaware, New Jersey, and Pennsylvania Environmental Sensitivity Index Atlas* **Host:** OR&R, NOAA **Year:** 2014 **Format:** .gdb **Description:** Exposed and sheltered sand and mud tidal flats. **Comment:** These habitats are included as part of the ESI POLYS feature.
ROCKY INTERTIDAL ZONES	**Coverage:** MA — Online Location **Title:** *Natural Heritage & Endangered Species Program (NHESP) Natural Communities* **Host:** MassGIS **Year:** 2016 **Format:** shp **Description:** Polygons that represent the extent of various natural communities of biodiversity conservation interest in Massachusetts. **Comment:** From 97 community types, 73 are Priority for conservation (ranked S1 through S3S4) and 24 types are more common or Low-priority for conservation (S4 and S5).

Habitat	Data Resource
SALT/BRACKISH WETLANDS	**Coverage:** MA [Online Location] **Title:** *Areas of Critical Environmental Concern* **Host:** MassGIS **Year:** 2009 **Format:** shp **Description:** Digital polygon and line boundaries for areas that have been designated ACECs by the Secretary of Energy and Environmental Affairs (EEA). ACECs are places in Massachusetts that receive special recognition because of the quality, uniqueness and significance of their natural and cultural resources. **Comment:** N/A
SALT/BRACKISH WETLANDS	**Coverage:** MA [Online Location] **Title:** *BioMap2* **Host:** MassGIS **Year:** 2011 **Format:** shp **Description:** Core Habitat (CH) identifies specific areas necessary to promote the long-term persistence of Species of Conservation Concern (those listed under the Massachusetts Endangered Species Act as well as additional species identified in the State Wildlife Action Plan), exemplary natural communities, and intact ecosystems **Comment:** N/A
SALT/BRACKISH WETLANDS	**Coverage:** MA [Online Location] **Title:** *Natural Heritage & Endangered Species Program (NHESP) Natural Communities* **Host:** MassGIS **Year:** 2016 **Format:** shp **Description:** Polygons that represent the extent of various natural communities of biodiversity conservation interest in Massachusetts. **Comment:** From 97 community types, 73 are Priority for conservation (ranked S1 through S3S4) and 24 types are more common or Low-priority for conservation (S4 and S5).
TIDAL FRESHWATER WETLANDS	**Coverage:** MA [Online Location] **Title:** *Natural Heritage & Endangered Species Program (NHESP) Natural Communities* **Host:** MassGIS **Year:** 2016 **Format:** shp **Description:** Polygons that represent the extent of various natural communities of biodiversity conservation interest in Massachusetts. **Comment:** From 97 community types, 73 are Priority for conservation (ranked S1 through S3S4) and 24 types are more common or Low-priority for conservation (S4 and S5).

Habitat	Data Resource					
SUBMERGED AQUATIC VEGETATION	**Coverage:**	ME			Online Location	
	Title:	*Eelgrass beds*				
	Host:	MOGIS	**Year:**	2013	**Format:**	shp
	Description:	Polygons representing eelgrass distribution in Maine coastal waters				
	Comment:	Data available for 1997, 2010, and 2013.				
SUBMERGED AQUATIC VEGETATION	**Coverage:**	ME			Online Location	
	Title:	*Northwest Atlantic Marine Ecoregional Assessment - Eelgrass*				
	Host:	TNC	**Year:**	2010	**Format:**	.gdb
	Description:	Eelgrass distribution compiled for states from Maine to North Carolina.				
	Comment:	Data can be accessed from Chapter 2: Coastal Ecosystems.				
SUBMERGED AQUATIC VEGETATION	**Coverage:**	NH			Online Location	
	Title:	*Eelgrass beds*				
	Host:	NH GRANIT	**Year:**	2014	**Format:**	shp
	Description:	Eelgrass beds in New Hampshire.				
	Comment:	Data available from 1981-2014.				
SUBMERGED AQUATIC VEGETATION	**Coverage:**	MA			Online Location	
	Title:	*Eelgrass*				
	Host:	MassGIS	**Year:**	2013	**Format:**	shp
	Description:	Polygons represented areas of eelgrass in Massachusetts, assessed from 2010 to 2013.				
	Comment:	Together the 2010, 2012, and 2013 layers cover the entire Massachusetts coastline.				
SUBMERGED AQUATIC VEGETATION	**Coverage:**	MA			Online Location	
	Title:	*Eelgrass*				
	Host:	MORIS	**Year:**	2015	**Format:**	shp
	Description:	Polygons represented areas of eelgrass in Massachusetts assessed in 2015.				
	Comment:	Desired data layer can be reviewed in the viewer, and then downloaded.				
SUBMERGED AQUATIC VEGETATION	**Coverage:**	MA			Online Location	
	Title:	*Natural Heritage & Endangered Species Program (NHESP) Natural Communities*				
	Host:	MassGIS	**Year:**	2016	**Format:**	shp
	Description:	Polygons that represent the extent of various natural communities of biodiversity conservation interest in Massachusetts.				
	Comment:	From 97 community types, 73 are Priority for conservation (ranked S1 through S3S4) and 24 types are more common or Low-priority for conservation (S4 and S5).				

Habitat	Data Resource
SUBMERGED AQUATIC VEGETATION	**Coverage:** RI [Online Location] **Title:** *Submerged Aquatic Vegetation (2012)* **Host:** RIGIS **Year:** 2012 **Format:** shp **Description:** Polygons representing eelgrass and widgeon grass. **Comment:** Data is available for multiple years between 2000 and 2012.
SUBMERGED AQUATIC VEGETATION	**Coverage:** CT, NY [Online Location] **Title:** *Long Island Sound Environmental Sensitivity Index Atlas* **Host:** OR&R, NOAA **Year:** 2016 **Format:** .gdb **Description:** Benthic habitats in Long Island Sound, including: SAV, algae, and shellfish. **Comment:** These habitats are included as part of the Biology BENTHIC feature.
SUBMERGED AQUATIC VEGETATION	**Coverage:** CT [Online Location] **Title:** *Eelgrass Beds 2012* **Host:** DEEP **Year:** 2012 **Format:** shp **Description:** Eelgrass beds in Connecticut. **Comment:** Data is available for multiple years between 2000, 2006, 2009, and 2012.
SUBMERGED AQUATIC VEGETATION	**Coverage:** NY, NJ [Online Location] **Title:** *New York-New Jersey Environmental Sensitivity Index Atlas* **Host:** OR&R, NOAA **Year:** 2016 **Format:** .gdb **Description:** Benthic habitats in New York/New Jersey, including: SAV, algae, and shellfish. **Comment:** These habitats are included as part of the Biology BENTHIC feature.
SUBMERGED AQUATIC VEGETATION	**Coverage:** NJ [Online Location] **Title:** *Submerged Aquatic Vegetation Mapping* **Host:** Rutgers University **Year:** 2009 **Format:** shp **Description:** Submerged aquatic vegetation in the coastal bays of New Jersey. **Comment:** SAV polygons for Barnegat Bay and Little Egg Harbor Estuary System
SUBMERGED AQUATIC VEGETATION	**Coverage:** NJ [Online Location] **Title:** *Delaware, New Jersey, and Pennsylvania Environmental Sensitivity Index Atlas* **Host:** OR&R, NOAA **Year:** 2014 **Format:** .gdb **Description:** Benthic habitats in Delaware, New Jersey, and Pennsylvania, including: SAV, algae, and shellfish. **Comment:** These habitats are included as part of the Biology BENTHIC feature.

Habitat	Data Resource					
SHELLFISH REEFS	**Coverage:**	ME				Online Location
	Title:	*Molluscan shellfish*				
	Host:	MOGIS	**Year:**	2010	**Format:**	shp
	Description:	Shellfish species distributions, including eastern and European oysters				
	Comment:	Separate shapefiles with polygons representing mollusk species found in Maine coastal waters, including shapefiles for eastern and European oyster distributions				
SHELLFISH REEFS	**Coverage:**	NH				Online Location
	Title:	*NHDES Marine Aquaculture Data 2015*				
	Host:	NH GRANIT	**Year:**	2015	**Format:**	shp
	Description:	2015 licensed aquaculture sites in NH's tidal waters.				
	Comment:	This is not a comprehensive collection of shellfish reefs and areas licensed to aquaculture may only represent potential habitat.				
SHELLFISH REEFS	**Coverage:**	CT				Online Location
	Title:	*Shellfish*				
	Host:	DEEP	**Year:**	1997	**Format:**	shp
	Description:	Approximate location of shellfish beds along the Connecticut coast				
	Comment:	N/A				
NEARSHORE HARD BOTTOM	**Coverage:**	MA				Online Location
	Title:	*Hard/Complex Seafloor*				
	Host:	MORIS	**Year:**	2015	**Format:**	shp
	Description:	Polygons representing hard/complex seafloor.				
	Comment:	Desired data layer can be reviewed in the viewer, and then downloaded.				
NEARSHORE SOFT BOTTOM	**Coverage:**	ME				Online Location
	Title:	*Northwest Atlantic Marine Ecoregional Assessment - Benthic habitats*				
	Host:	TNC	**Year:**	2010	**Format:**	.gdb
	Description:	Benthic habitats are combinations of Ecological Marine Units (depth, sediment grain size, and seabed forms) considered with their species assemblages.				
	Comment:	Data can be accessed from Chapter 3 - Benthic habitats				
WATER COLUMN	**Coverage:**	MA				Online Location
	Title:	*Areas of Critical Environmental Concern*				
	Host:	MassGIS	**Year:**	2009	**Format:**	shp
	Description:	Digital polygon and line boundaries for areas that have been designated ACECs by the Secretary of Energy and Environmental Affairs (EEA). ACECs are places in Massachusetts that receive special recognition because of the quality, uniqueness and significance of their natural and cultural resources.				
	Comment:	N/A				

Habitat	Data Resource
DEVELOPED AREAS/RIGHTS-OF-WAY	**Coverage:** NH — Online Location **Title:** *Impervious Surfaces in Coastal New Hampshire* **Host:** NH GRANIT **Year:** 2005 **Format:** shp **Description:** Impervious Surfaces in Coastal New Hampshire **Comment:** N/A
DEVELOPED AREAS/RIGHTS-OF-WAY	**Coverage:** MA — Online Location **Title:** *Impervious Surfaces* **Host:** MassGIS **Year:** 2007 **Format:** shp **Description:** Impervious surfaces in Massachusetts in 2007. **Comment:** N/A
DEVELOPED AREAS/RIGHTS-OF-WAY	**Coverage:** RI — Online Location **Title:** *Impervious Surfaces* **Host:** RIGIS **Year:** 2011 **Format:** shp **Description:** Impervious surfaces in Rhode Island in 2011. **Comment:** N/A
DEVELOPED AREAS/RIGHTS-OF-WAY	**Coverage:** NJ — Online Location **Title:** *2012 Impervious Surface Estimation in New Jersey* **Host:** NJDEP **Year:** 2012 **Format:** shp **Description:** Materials such as concrete and asphalt that compose roadways, parking areas, sidewalks and buildings classified from 2012 imagery. **Comment:** N/A

Table A-3. Data sources with coverage of the Mid-Atlantic Planning Area. Publicly available geospatial data for mapping coastal, intertidal, and nearshore marine habitats. Details for each dataset include its title, brief description of what the data includes, comments for appropriate application, data format (shapefile, shp; geodatabase, gdb; keyhole markup language zipped, kmz), the organization hosting the data, the currentness of the data, and a link to where the data may be downloaded.

Habitat	Data Resource					
COASTAL UPLANDS	**Coverage:**	DE, MD, VA			Online Location	
	Title:	*Northeast Terrestrial Habitat Mapping Project*				
	Host:	TNC	**Year:**	2011	**Format:**	tif
	Description:	Terrestrial habitats from Maine to Virginia classified based on NatureServe's Ecological Systems Classification.				
	Comment:	N/A				
COASTAL UPLANDS	**Coverage:**	MD			Online Location	
	Title:	*Maryland Living Resources - Sensitive Species Project Review Areas*				
	Host:	MD iMAP, DNR	**Year:**	2010	**Format:**	shp/kml
	Description:	Buffered areas that primarily contain habitat for rare, threatened, and endangered species and rare natural community types.				
	Comment:	N/A				
DUNES	**Coverage:**	DE, MD, VA			Online Location	
	Title:	*Northeast Terrestrial Habitat Mapping Project*				
	Host:	TNC	**Year:**	2011	**Format:**	tif
	Description:	Terrestrial habitats from Maine to Virginia classified based on NatureServe's Ecological Systems Classification.				
	Comment:	N/A				
DUNES	**Coverage:**	MD			Online Location	
	Title:	*Maryland Living Resources - Sensitive Species Project Review Areas*				
	Host:	MD iMAP, DNR	**Year:**	2010	**Format:**	shp/kml
	Description:	Buffered areas that primarily contain habitat for rare, threatened, and endangered species and rare natural community types.				
	Comment:	N/A				
BEACHES	**Coverage:**	DE			Online Location	
	Title:	*Delaware, New Jersey, and Pennsylvania Environmental Sensitivity Index Atlas*				
	Host:	OR&R, NOAA	**Year:**	2014	**Format:**	gdb
	Description:	Linear extents of beaches.				
	Comment:	These habitats are shown as polygons included in the ESI POLYS feature class.				
BEACHES	**Coverage:**	MD, VA			Online Location	
	Title:	*Chesapeake Bay and the Outer Coasts of Maryland and Virginia*				
	Host:	OR&R, NOAA	**Year:**	2016	**Format:**	gdb
	Description:	Linear extents of beaches.				
	Comment:	These habitats are included as part of the ESIL feature. Data from a 2016 update is expected to become available in the coming months.				

Habitat		Data Resource
BEACHES	**Coverage:**	MD — Online Location
	Title:	*Maryland Living Resources - Sensitive Species Project Review Areas*
	Host:	MD iMAP, DNR **Year:** 2010 **Format:** shp/kml
	Description:	Buffered areas that primarily contain habitat for rare, threatened, and endangered species and rare natural community types.
	Comment:	N/A
BEACHES	**Coverage:**	NC — Online Location
	Title:	*North Carolina Environmental Sensitivity Atlas*
	Host:	OR&R, NOAA **Year:** 2016 **Format:** gdb
	Description:	Linear extents of beaches.
	Comment:	These habitats are included as part of the ESIL feature. Data from a 2016 update is expected to become available in the coming months.
TIDAL FLATS	**Coverage:**	DE — Online Location
	Title:	*Delaware, New Jersey, and Pennsylvania Environmental Sensitivity Index Atlas*
	Host:	OR&R, NOAA **Year:** 2014 **Format:** gdb
	Description:	Exposed and sheltered sand and mud tidal flats.
	Comment:	These habitats are included as part of the ESI POLYS feature.
TIDAL FLATS	**Coverage:**	MD, VA — Online Location
	Title:	*Chesapeake Bay and the Outer Coasts of Maryland and Virginia*
	Host:	OR&R, NOAA **Year:** 2016 **Format:** gdb
	Description:	Exposed and sheltered sand and mud tidal flats.
	Comment:	These habitats are included as part of the ESIP feature. Data from a 2016 update is expected to become available in the coming months.
TIDAL FLATS	**Coverage:**	NC — Online Location
	Title:	*North Carolina Environmental Sensitivity Atlas*
	Host:	OR&R, NOAA **Year:** 2016 **Format:** gdb
	Description:	Exposed and sheltered sand and mud tidal flats.
	Comment:	These habitats are included as part of the ESIP feature. Data from a 2016 update is expected to become available in the coming months.
SALT/BRACKISH WETLANDS	**Coverage:**	MD, VA — Online Location
	Title:	*Chesapeake Bay and the Outer Coasts of Maryland and Virginia*
	Host:	OR&R, NOAA **Year:** 2016 **Format:** gdb
	Description:	Based on a subset of categories from the National Wetland Inventory, wetlands include: salt- and brackish marshes, freshwater marshes, scrub-shrub wetlands, and swamps.
	Comment:	These habitats are included as part of the Biology ESIP feature. Data from a 2016 update is expected to become available in the coming months.

Habitat		Data Resource
SALT/BRACKISH WETLANDS	**Coverage:**	MD — Online Location
	Title:	*Maryland Living Resources - Natural Heritage Areas*
	Host:	MD iMAP, DNR **Year:** 2010 **Format:** shp/kml
	Description:	Denotes the 32 areas designated in the state's Threatened and Endangered Species regulations (COMAR 08.03.08) under section .10 Natural (1) Contain one or more threatened or endangered species or wildlife species in need of conservation; (2) Be a unique blend of geological, hydrological, climatological or biological features; and (3) Be considered to be among the best Statewide examples of its kind.
	Comment:	N/A
SALT/BRACKISH WETLANDS	**Coverage:**	MD — Online Location
	Title:	*Maryland Living Resources - Sensitive Species Project Review Areas*
	Host:	MD iMAP, DNR **Year:** 2010 **Format:** shp/kml
	Description:	Buffered areas that primarily contain habitat for rare, threatened, and endangered species and rare natural community types.
	Comment:	N/A
SALT/BRACKISH WETLANDS	**Coverage:**	NC — Online Location
	Title:	*North Carolina Environmental Sensitivity Atlas*
	Host:	OR&R, NOAA **Year:** 2016 **Format:** gdb
	Description:	Based on a subset of categories from the National Wetland Inventory, wetlands include: salt- and brackish marshes, freshwater marshes, scrub-shrub wetlands, and swamps.
	Comment:	N/A
TIDAL FRESHWATER WETLANDS	**Coverage:**	MD, VA — Online Location
	Title:	*Chesapeake Bay and the Outer Coasts of Maryland and Virginia*
	Host:	OR&R, NOAA **Year:** 2016 **Format:** gdb
	Description:	Based on a subset of categories from the National Wetland Inventory, wetlands include: salt- and brackish marshes, freshwater marshes, scrub-shrub wetlands, and swamps.
	Comment:	These habitats are included as part of the Biology ESIP feature. Data from a 2016 update is expected to become available in the coming months.

Habitat	Data Resource
TIDAL FRESHWATER WETLANDS	**Coverage:** MD — Online Location **Title:** *Maryland Living Resources - Natural Heritage Areas* **Host:** MD iMAP, DNR **Year:** 2010 **Format:** shp/kml **Description:** Denotes the 32 areas designated in the state's Threatened and Endangered Species regulations (COMAR 08.03.08) under section .10 Natural (1) Contain one or more threatened or endangered species or wildlife species in need of conservation; (2) Be a unique blend of geological, hydrological, climatological or biological features; and (3) Be considered to be among the best Statewide examples of its kind. **Comment:** N/A
TIDAL FRESHWATER WETLANDS	**Coverage:** MD — Online Location **Title:** *Maryland Living Resources - Sensitive Species Project Review Areas* **Host:** MD iMAP, DNR **Year:** 2010 **Format:** shp/kml **Description:** Buffered areas that primarily contain habitat for rare, threatened, and endangered species and rare natural community types. **Comment:** N/A
TIDAL FRESHWATER WETLANDS	**Coverage:** NC — Online Location **Title:** *North Carolina Environmental Sensitivity Atlas* **Host:** OR&R, NOAA **Year:** 2016 **Format:** gdb **Description:** Based on a subset of categories from the National Wetland Inventory, wetlands include: salt- and brackish marshes, freshwater marshes, scrub-shrub wetlands, and swamps. **Comment:** N/A
SUBMERGED AQUATIC VEGETATION	**Coverage:** DE, MD, VA, NC — Online Location **Title:** *Northwest Atlantic Marine Ecoregional Assessment - Eelgrass* **Host:** TNC **Year:** 2010 **Format:** gdb **Description:** Eelgrass distribution compiled for states from Maine to North Carolina. **Comment:** Data can be accessed from Chapter 2: Coastal Ecosystems.
SUBMERGED AQUATIC VEGETATION	**Coverage:** DE — Online Location **Title:** *Delaware, New Jersey, and Pennsylvania Environmental Sensitivity Index Atlas* **Host:** OR&R, NOAA **Year:** 2014 **Format:** gdb **Description:** Benthic habitats in Delaware, New Jersey, and Pennsylvania, including: SAV, algae, and shellfish. **Comment:** These habitats are included as part of the Biology BENTHIC feature.

Habitat		Data Resource				
SUBMERGED AQUATIC VEGETATION	**Coverage:**	MD, VA			Online Location	
	Title:	*Chesapeake Bay and the Outer Coasts of Maryland and Virginia*				
	Host:	OR&R, NOAA	**Year:**	2016	**Format:**	gdb
	Description:	Submerged aquatic vegetation in Chesapeake Bay and Maryland and Virginia coastal bays.				
	Comment:	These habitats are included as part of the Biology BENTHIC feature. Data from a 2016 update is expected to become available in the coming months.				
SUBMERGED AQUATIC VEGETATION	**Coverage:**	MD, VA			Online Location	
	Title:	*SAV in Chesapeake and Coastal Bays*				
	Host:	VIMS	**Year:**	2014	**Format:**	shp/ascii
	Description:	Polygonal data depicting seagrass percent coverage				
	Comment:	Data available from 1971-2014				
SUBMERGED AQUATIC VEGETATION	**Coverage:**	NC			Online Location	
	Title:	*Submerged Aquatic Vegetation - SAV*				
	Host:	NCDENR, APNEP	**Year:**	2008	**Format:**	shp
	Description:	Coastal submerged aquatic vegetation (SAV)				
	Comment:	N/A				
SHELLFISH REEFS	**Coverage:**	DE			Online Location	
	Title:	*Delaware, New Jersey, and Pennsylvania Environmental Sensitivity Index Atlas*				
	Host:	OR&R, NOAA	**Year:**	2014	**Format:**	gdb
	Description:	Benthic habitats in Delaware, New Jersey, and Pennsylvania, including: SAV, algae, and shellfish.				
	Comment:	These habitats are included as part of the Biology INVERTEBRATES feature.				
SHELLFISH REEFS	**Coverage:**	MD, VA			Online Location	
	Title:	*Chesapeake Bay and the Outer Coasts of Maryland and Virginia*				
	Host:	OR&R, NOAA	**Year:**	2016	**Format:**	gdb
	Description:	Shellfish distribution in Chesapeake Bay and Maryland and Virginia coastal bays.				
	Comment:	These habitats are included as part of the Biology INVERTEBRATES feature. Data from a 2016 update is expected to become available in the coming months.				
SHELLFISH REEFS	**Coverage:**	NC			Online Location	
	Title:	*Estuarine Benthic Habitat Mapping*				
	Host:	NC DMF	**Year:**	2013	**Format:**	shp
	Description:	Shellfish-producing areas and delineated potentially productive benthic shellfish habitats.				
	Comment:	N/A				

Habitat	Data Resource					
NEARSHORE SOFT BOTTOM	**Coverage:**	DE, MD, VA, NC			Online Location	
	Title:	*Northwest Atlantic Marine Ecoregional Assessment - Benthic habitats*				
	Host:	TNC	**Year:**	2010	**Format:**	gdb
	Description:	Benthic habitats are combinations of Ecological Marine Units (depth, sediment grain size, and seabed forms) considered with their species assemblages.				
	Comment:	Data can be accessed from Chapter 3 - Benthic habitats				
NEARSHORE SOFT BOTTOM	**Coverage:**	NC			Online Location	
	Title:	*North Carolina Soft Bottom Habitats*				
	Host:	NCDMF	**Year:**	2015	**Format:**	shp
	Description:	Soft-bottom habitats from the NC Coastal Habitat Protection Plan				
	Comment:	N/A				

Table A-4. Data sources with coverage of the South Atlantic Planning Area. Publicly available geospatial data for mapping coastal, intertidal, and nearshore marine habitats. Details for each dataset include its title, brief description of what the data includes, comments for appropriate application, data format (shapefile, shp; geodatabase, gdb; keyhole markup language zipped, kmz), the organization hosting the data, the currentness of the data, and a link to where the data may be downloaded.

Habitat	Data Resource				
COASTAL UPLANDS	**Coverage:**	DE, MD, VA		Online Location	
	Title:	*Northeast Terrestrial Habitat Mapping Project*			
	Host:	TNC	**Year:** 2011	**Format:**	tif
	Description:	Terrestrial habitats from Maine to Virginia classified based on NatureServe's Ecological Systems Classification.			
	Comment:	N/A			
COASTAL UPLANDS	**Coverage:**	MD		Online Location	
	Title:	*Maryland Living Resources - Sensitive Species Project Review Areas*			
	Host:	MD iMAP, DNR	**Year:** 2010	**Format:**	shp/kml
	Description:	Buffered areas that primarily contain habitat for rare, threatened, and endangered species and rare natural community types.			
	Comment:	N/A			
DUNES	**Coverage:**	DE, MD, VA		Online Location	
	Title:	*Northeast Terrestrial Habitat Mapping Project*			
	Host:	TNC	**Year:** 2011	**Format:**	tif
	Description:	Terrestrial habitats from Maine to Virginia classified based on NatureServe's Ecological Systems Classification.			
	Comment:	N/A			
DUNES	**Coverage:**	MD		Online Location	
	Title:	*Maryland Living Resources - Sensitive Species Project Review Areas*			
	Host:	MD iMAP, DNR	**Year:** 2010	**Format:**	shp/kml
	Description:	Buffered areas that primarily contain habitat for rare, threatened, and endangered species and rare natural community types.			
	Comment:	N/A			
BEACHES	**Coverage:**	DE		Online Location	
	Title:	*Delaware, New Jersey, and Pennsylvania Environmental Sensitivity Index Atlas*			
	Host:	OR&R, NOAA	**Year:** 2014	**Format:**	gdb
	Description:	Linear extents of beaches.			
	Comment:	These habitats are shown as polygons included in the ESI POLYS feature class.			
BEACHES	**Coverage:**	MD, VA		Online Location	
	Title:	*Chesapeake Bay and the Outer Coasts of Maryland and Virginia*			
	Host:	OR&R, NOAA	**Year:** 2016	**Format:**	gdb
	Description:	Linear extents of beaches.			
	Comment:	These habitats are included as part of the ESIL feature. Data from a 2016 update is expected to become available in the coming months.			

Habitat		Data Resource
BEACHES	**Coverage:**	MD [Online Location]
	Title:	*Maryland Living Resources - Sensitive Species Project Review Areas*
	Host:	MD iMAP, DNR **Year:** 2010 **Format:** shp/kml
	Description:	Buffered areas that primarily contain habitat for rare, threatened, and endangered species and rare natural community types.
	Comment:	N/A
BEACHES	**Coverage:**	NC [Online Location]
	Title:	*North Carolina Environmental Sensitivity Atlas*
	Host:	OR&R, NOAA **Year:** 2016 **Format:** gdb
	Description:	Linear extents of beaches.
	Comment:	These habitats are included as part of the ESIL feature. Data from a 2016 update is expected to become available in the coming months.
TIDAL FLATS	**Coverage:**	DE [Online Location]
	Title:	*Delaware, New Jersey, and Pennsylvania Environmental Sensitivity Index Atlas*
	Host:	OR&R, NOAA **Year:** 2014 **Format:** gdb
	Description:	Exposed and sheltered sand and mud tidal flats.
	Comment:	These habitats are included as part of the ESI POLYS feature.
TIDAL FLATS	**Coverage:**	MD, VA [Online Location]
	Title:	*Chesapeake Bay and the Outer Coasts of Maryland and Virginia*
	Host:	OR&R, NOAA **Year:** 2016 **Format:** gdb
	Description:	Exposed and sheltered sand and mud tidal flats.
	Comment:	These habitats are included as part of the ESIP feature. Data from a 2016 update is expected to become available in the coming months.
TIDAL FLATS	**Coverage:**	NC [Online Location]
	Title:	*North Carolina Environmental Sensitivity Atlas*
	Host:	OR&R, NOAA **Year:** 2016 **Format:** gdb
	Description:	Exposed and sheltered sand and mud tidal flats.
	Comment:	These habitats are included as part of the ESIP feature. Data from a 2016 update is expected to become available in the coming months.
SALT/BRACKISH WETLANDS	**Coverage:**	MD, VA [Online Location]
	Title:	*Chesapeake Bay and the Outer Coasts of Maryland and Virginia*
	Host:	OR&R, NOAA **Year:** 2016 **Format:** gdb
	Description:	Based on a subset of categories from the National Wetland Inventory, wetlands include: salt- and brackish marshes, freshwater marshes, scrub-shrub wetlands, and swamps.
	Comment:	These habitats are included as part of the Biology ESIP feature. Data from a 2016 update is expected to become available in the coming months.

Habitat		Data Resource
SALT/BRACKISH WETLANDS	**Coverage:**	MD Online Location
	Title:	*Maryland Living Resources - Natural Heritage Areas*
	Host:	MD iMAP, DNR **Year:** 2010 **Format:** shp/kml
	Description:	Denotes the 32 areas designated in the state's Threatened and Endangered Species regulations (COMAR 08.03.08) under section .10 Natural (1) Contain one or more threatened or endangered species or wildlife species in need of conservation; (2) Be a unique blend of geological, hydrological, climatological or biological features; and (3) Be considered to be among the best Statewide examples of its kind.
	Comment:	N/A
SALT/BRACKISH WETLANDS	**Coverage:**	MD Online Location
	Title:	*Maryland Living Resources - Sensitive Species Project Review Areas*
	Host:	MD iMAP, DNR **Year:** 2010 **Format:** shp/kml
	Description:	Buffered areas that primarily contain habitat for rare, threatened, and endangered species and rare natural community types.
	Comment:	N/A
SALT/BRACKISH WETLANDS	**Coverage:**	NC Online Location
	Title:	*North Carolina Environmental Sensitivity Atlas*
	Host:	OR&R, NOAA **Year:** 2016 **Format:** gdb
	Description:	Based on a subset of categories from the National Wetland Inventory, wetlands include: salt- and brackish marshes, freshwater marshes, scrub-shrub wetlands, and swamps.
	Comment:	N/A
TIDAL FRESHWATER WETLANDS	**Coverage:**	MD, VA Online Location
	Title:	*Chesapeake Bay and the Outer Coasts of Maryland and Virginia*
	Host:	OR&R, NOAA **Year:** 2016 **Format:** gdb
	Description:	Based on a subset of categories from the National Wetland Inventory, wetlands include: salt- and brackish marshes, freshwater marshes, scrub-shrub wetlands, and swamps.
	Comment:	These habitats are included as part of the Biology ESIP feature. Data from a 2016 update is expected to become available in the coming months.

Habitat		Data Resource
TIDAL FRESHWATER WETLANDS	**Coverage:**	MD — Online Location
	Title:	*Maryland Living Resources - Natural Heritage Areas*
	Host:	MD iMAP, DNR **Year:** 2010 **Format:** shp/kml
	Description:	Denotes the 32 areas designated in the state's Threatened and Endangered Species regulations (COMAR 08.03.08) under section .10 Natural (1) Contain one or more threatened or endangered species or wildlife species in need of conservation; (2) Be a unique blend of geological, hydrological, climatological or biological features; and (3) Be considered to be among the best Statewide examples of its kind.
	Comment:	N/A
TIDAL FRESHWATER WETLANDS	**Coverage:**	MD — Online Location
	Title:	*Maryland Living Resources - Sensitive Species Project Review Areas*
	Host:	MD iMAP, DNR **Year:** 2010 **Format:** shp/kml
	Description:	Buffered areas that primarily contain habitat for rare, threatened, and endangered species and rare natural community types.
	Comment:	N/A
TIDAL FRESHWATER WETLANDS	**Coverage:**	NC — Online Location
	Title:	*North Carolina Environmental Sensitivity Atlas*
	Host:	OR&R, NOAA **Year:** 2016 **Format:** gdb
	Description:	Based on a subset of categories from the National Wetland Inventory, wetlands include: salt- and brackish marshes, freshwater marshes, scrub-shrub wetlands, and swamps.
	Comment:	N/A
SUBMERGED AQUATIC VEGETATION	**Coverage:**	DE, MD, VA, NC — Online Location
	Title:	*Northwest Atlantic Marine Ecoregional Assessment - Eelgrass*
	Host:	TNC **Year:** 2010 **Format:** gdb
	Description:	Eelgrass distribution compiled for states from Maine to North Carolina.
	Comment:	Data can be accessed from Chapter 2: Coastal Ecosystems.
SUBMERGED AQUATIC VEGETATION	**Coverage:**	DE — Online Location
	Title:	*Delaware, New Jersey, and Pennsylvania Environmental Sensitivity Index Atlas*
	Host:	OR&R, NOAA **Year:** 2014 **Format:** gdb
	Description:	Benthic habitats in Delaware, New Jersey, and Pennsylvania, including: SAV, algae, and shellfish.
	Comment:	These habitats are included as part of the Biology BENTHIC feature.

Habitat	Data Resource	
SUBMERGED AQUATIC VEGETATION	**Coverage:**	MD, VA [Online Location]
	Title:	*Chesapeake Bay and the Outer Coasts of Maryland and Virginia*
	Host:	OR&R, NOAA **Year:** 2016 **Format:** gdb
	Description:	Submerged aquatic vegetation in Chesapeake Bay and Maryland and Virginia coastal bays.
	Comment:	These habitats are included as part of the Biology BENTHIC feature. Data from a 2016 update is expected to become available in the coming months.
SUBMERGED AQUATIC VEGETATION	**Coverage:**	MD, VA [Online Location]
	Title:	*SAV in Chesapeake and Coastal Bays*
	Host:	VIMS **Year:** 2014 **Format:** shp/ascii
	Description:	Polygonal data depicting seagrass percent coverage
	Comment:	Data available from 1971-2014
SUBMERGED AQUATIC VEGETATION	**Coverage:**	NC [Online Location]
	Title:	*Submerged Aquatic Vegetation - SAV*
	Host:	NCDENR, APNEP **Year:** 2008 **Format:** shp
	Description:	Coastal submerged aquatic vegetation (SAV)
	Comment:	N/A
SHELLFISH REEFS	**Coverage:**	DE [Online Location]
	Title:	*Delaware, New Jersey, and Pennsylvania Environmental Sensitivity Index Atlas*
	Host:	OR&R, NOAA **Year:** 2014 **Format:** gdb
	Description:	Benthic habitats in Delaware, New Jersey, and Pennsylvania, including: SAV, algae, and shellfish.
	Comment:	These habitats are included as part of the Biology INVERTEBRATES feature.
SHELLFISH REEFS	**Coverage:**	MD, VA [Online Location]
	Title:	*Chesapeake Bay and the Outer Coasts of Maryland and Virginia*
	Host:	OR&R, NOAA **Year:** 2016 **Format:** gdb
	Description:	Shellfish distribution in Chesapeake Bay and Maryland and Virginia coastal bays.
	Comment:	These habitats are included as part of the Biology INVERTEBRATES feature. Data from a 2016 update is expected to become available in the coming months.
SHELLFISH REEFS	**Coverage:**	NC [Online Location]
	Title:	*Estuarine Benthic Habitat Mapping*
	Host:	NC DMF **Year:** 2013 **Format:** shp
	Description:	Shellfish-producing areas and delineated potentially productive benthic shellfish habitats.
	Comment:	N/A

Habitat	Data Resource					
NEARSHORE SOFT BOTTOM	**Coverage:**	DE, MD, VA, NC		[Online Location]()		
	Title:	*Northwest Atlantic Marine Ecoregional Assessment - Benthic habitats*				
	Host:	TNC	**Year:**	2010	**Format:**	gdb
	Description:	Benthic habitats are combinations of Ecological Marine Units (depth, sediment grain size, and seabed forms) considered with their species assemblages.				
	Comment:	Data can be accessed from Chapter 3 - Benthic habitats				
NEARSHORE SOFT BOTTOM	**Coverage:**	NC		[Online Location]()		
	Title:	*North Carolina Soft Bottom Habitats*				
	Host:	NCDMF	**Year:**	2015	**Format:**	shp
	Description:	Soft-bottom habitats from the NC Coastal Habitat Protection Plan				
	Comment:	N/A				

Table A-5. Data sources with coverage of the Straits of Florida Planning Area. Publicly available geospatial data for mapping coastal, intertidal, and nearshore marine habitats. Details for each dataset include its title, brief description of what the data includes, comments for appropriate application, data format (shapefile, shp; geodatabase, gdb; keyhole markup language zipped, kmz), the organization hosting the data, the currentness of the data, and a link to where the data may be downloaded.

Habitat	Data Resource					
COASTAL UPLANDS	**Coverage:**	DE, MD, VA		Online Location		
	Title:	*Northeast Terrestrial Habitat Mapping Project*				
	Host:	TNC	**Year:**	2011	**Format:**	tif
	Description:	Terrestrial habitats from Maine to Virginia classified based on NatureServe's Ecological Systems Classification.				
	Comment:	N/A				
COASTAL UPLANDS	**Coverage:**	MD		Online Location		
	Title:	*Maryland Living Resources - Sensitive Species Project Review Areas*				
	Host:	MD iMAP, DNR	**Year:**	2010	**Format:**	shp/kml
	Description:	Buffered areas that primarily contain habitat for rare, threatened, and endangered species and rare natural community types.				
	Comment:	N/A				
DUNES	**Coverage:**	DE, MD, VA		Online Location		
	Title:	*Northeast Terrestrial Habitat Mapping Project*				
	Host:	TNC	**Year:**	2011	**Format:**	tif
	Description:	Terrestrial habitats from Maine to Virginia classified based on NatureServe's Ecological Systems Classification.				
	Comment:	N/A				
DUNES	**Coverage:**	MD		Online Location		
	Title:	*Maryland Living Resources - Sensitive Species Project Review Areas*				
	Host:	MD iMAP, DNR	**Year:**	2010	**Format:**	shp/kml
	Description:	Buffered areas that primarily contain habitat for rare, threatened, and endangered species and rare natural community types.				
	Comment:	N/A				
BEACHES	**Coverage:**	DE		Online Location		
	Title:	*Delaware, New Jersey, and Pennsylvania Environmental Sensitivity Index Atlas*				
	Host:	OR&R, NOAA	**Year:**	2014	**Format:**	gdb
	Description:	Linear extents of beaches.				
	Comment:	These habitats are shown as polygons included in the ESI POLYS feature class.				
BEACHES	**Coverage:**	MD, VA		Online Location		
	Title:	*Chesapeake Bay and the Outer Coasts of Maryland and Virginia*				
	Host:	OR&R, NOAA	**Year:**	2016	**Format:**	gdb
	Description:	Linear extents of beaches.				
	Comment:	These habitats are included as part of the ESIL feature. Data from a 2016 update is expected to become available in the coming months.				

Habitat		Data Resource				
BEACHES	**Coverage:**	MD				Online Location
	Title:	*Maryland Living Resources - Sensitive Species Project Review Areas*				
	Host:	MD iMAP, DNR	**Year:**	2010	**Format:**	shp/kml
	Description:	Buffered areas that primarily contain habitat for rare, threatened, and endangered species and rare natural community types.				
	Comment:	N/A				
BEACHES	**Coverage:**	NC				Online Location
	Title:	*North Carolina Environmental Sensitivity Atlas*				
	Host:	OR&R, NOAA	**Year:**	2016	**Format:**	gdb
	Description:	Linear extents of beaches.				
	Comment:	These habitats are included as part of the ESIL feature. Data from a 2016 update is expected to become available in the coming months.				
TIDAL FLATS	**Coverage:**	DE				Online Location
	Title:	*Delaware, New Jersey, and Pennsylvania Environmental Sensitivity Index Atlas*				
	Host:	OR&R, NOAA	**Year:**	2014	**Format:**	gdb
	Description:	Exposed and sheltered sand and mud tidal flats.				
	Comment:	These habitats are included as part of the ESI POLYS feature.				
TIDAL FLATS	**Coverage:**	MD, VA				Online Location
	Title:	*Chesapeake Bay and the Outer Coasts of Maryland and Virginia*				
	Host:	OR&R, NOAA	**Year:**	2016	**Format:**	gdb
	Description:	Exposed and sheltered sand and mud tidal flats.				
	Comment:	These habitats are included as part of the ESIP feature. Data from a 2016 update is expected to become available in the coming months.				
TIDAL FLATS	**Coverage:**	NC				Online Location
	Title:	*North Carolina Environmental Sensitivity Atlas*				
	Host:	OR&R, NOAA	**Year:**	2016	**Format:**	gdb
	Description:	Exposed and sheltered sand and mud tidal flats.				
	Comment:	These habitats are included as part of the ESIP feature. Data from a 2016 update is expected to become available in the coming months.				
SALT/BRACKISH WETLANDS	**Coverage:**	MD, VA				Online Location
	Title:	*Chesapeake Bay and the Outer Coasts of Maryland and Virginia*				
	Host:	OR&R, NOAA	**Year:**	2016	**Format:**	gdb
	Description:	Based on a subset of categories from the National Wetland Inventory, wetlands include: salt- and brackish marshes, freshwater marshes, scrub-shrub wetlands, and swamps.				
	Comment:	These habitats are included as part of the Biology ESIP feature. Data from a 2016 update is expected to become available in the coming months.				

Habitat	Data Resource		
SALT/BRACKISH WETLANDS	**Coverage:**	MD	[Online Location]
	Title:	*Maryland Living Resources - Natural Heritage Areas*	
	Host:	MD iMAP, DNR **Year:** 2010 **Format:** shp/kml	
	Description:	Denotes the 32 areas designated in the state's Threatened and Endangered Species regulations (COMAR 08.03.08) under section .10 Natural (1) Contain one or more threatened or endangered species or wildlife species in need of conservation; (2) Be a unique blend of geological, hydrological, climatological or biological features; and (3) Be considered to be among the best Statewide examples of its kind.	
	Comment:	N/A	
SALT/BRACKISH WETLANDS	**Coverage:**	MD	[Online Location]
	Title:	*Maryland Living Resources - Sensitive Species Project Review Areas*	
	Host:	MD iMAP, DNR **Year:** 2010 **Format:** shp/kml	
	Description:	Buffered areas that primarily contain habitat for rare, threatened, and endangered species and rare natural community types.	
	Comment:	N/A	
SALT/BRACKISH WETLANDS	**Coverage:**	NC	[Online Location]
	Title:	*North Carolina Environmental Sensitivity Atlas*	
	Host:	OR&R, NOAA **Year:** 2016 **Format:** gdb	
	Description:	Based on a subset of categories from the National Wetland Inventory, wetlands include: salt- and brackish marshes, freshwater marshes, scrub-shrub wetlands, and swamps.	
	Comment:	N/A	
TIDAL FRESHWATER WETLANDS	**Coverage:**	MD, VA	[Online Location]
	Title:	*Chesapeake Bay and the Outer Coasts of Maryland and Virginia*	
	Host:	OR&R, NOAA **Year:** 2016 **Format:** gdb	
	Description:	Based on a subset of categories from the National Wetland Inventory, wetlands include: salt- and brackish marshes, freshwater marshes, scrub-shrub wetlands, and swamps.	
	Comment:	These habitats are included as part of the Biology ESIP feature. Data from a 2016 update is expected to become available in the coming months.	

Habitat	Data Resource		
TIDAL FRESHWATER WETLANDS	**Coverage:**	MD	Online Location
	Title:	*Maryland Living Resources - Natural Heritage Areas*	
	Host:	MD iMAP, DNR **Year:** 2010 **Format:** shp/kml	
	Description:	Denotes the 32 areas designated in the state's Threatened and Endangered Species regulations (COMAR 08.03.08) under section .10 Natural (1) Contain one or more threatened or endangered species or wildlife species in need of conservation; (2) Be a unique blend of geological, hydrological, climatological or biological features; and (3) Be considered to be among the best Statewide examples of its kind.	
	Comment:	N/A	
TIDAL FRESHWATER WETLANDS	**Coverage:**	MD	Online Location
	Title:	*Maryland Living Resources - Sensitive Species Project Review Areas*	
	Host:	MD iMAP, DNR **Year:** 2010 **Format:** shp/kml	
	Description:	Buffered areas that primarily contain habitat for rare, threatened, and endangered species and rare natural community types.	
	Comment:	N/A	
TIDAL FRESHWATER WETLANDS	**Coverage:**	NC	Online Location
	Title:	*North Carolina Environmental Sensitivity Atlas*	
	Host:	OR&R, NOAA **Year:** 2016 **Format:** gdb	
	Description:	Based on a subset of categories from the National Wetland Inventory, wetlands include: salt- and brackish marshes, freshwater marshes, scrub-shrub wetlands, and swamps.	
	Comment:	N/A	
SUBMERGED AQUATIC VEGETATION	**Coverage:**	DE, MD, VA, NC	Online Location
	Title:	*Northwest Atlantic Marine Ecoregional Assessment - Eelgrass*	
	Host:	TNC **Year:** 2010 **Format:** gdb	
	Description:	Eelgrass distribution compiled for states from Maine to North Carolina.	
	Comment:	Data can be accessed from Chapter 2: Coastal Ecosystems.	
SUBMERGED AQUATIC VEGETATION	**Coverage:**	DE	Online Location
	Title:	*Delaware, New Jersey, and Pennsylvania Environmental Sensitivity Index Atlas*	
	Host:	OR&R, NOAA **Year:** 2014 **Format:** gdb	
	Description:	Benthic habitats in Delaware, New Jersey, and Pennsylvania, including: SAV, algae, and shellfish.	
	Comment:	These habitats are included as part of the Biology BENTHIC feature.	

Habitat		Data Resource				
SUBMERGED AQUATIC VEGETATION	**Coverage:**	MD, VA		Online Location		
	Title:	*Chesapeake Bay and the Outer Coasts of Maryland and Virginia*				
	Host:	OR&R, NOAA	**Year:**	2016	**Format:**	gdb
	Description:	Submerged aquatic vegetation in Chesapeake Bay and Maryland and Virginia coastal bays.				
	Comment:	These habitats are included as part of the Biology BENTHIC feature. Data from a 2016 update is expected to become available in the coming months.				
SUBMERGED AQUATIC VEGETATION	**Coverage:**	MD, VA		Online Location		
	Title:	*SAV in Chesapeake and Coastal Bays*				
	Host:	VIMS	**Year:**	2014	**Format:**	shp/ascii
	Description:	Polygonal data depicting seagrass percent coverage				
	Comment:	Data available from 1971-2014				
SUBMERGED AQUATIC VEGETATION	**Coverage:**	NC		Online Location		
	Title:	*Submerged Aquatic Vegetation - SAV*				
	Host:	NCDENR, APNEP	**Year:**	2008	**Format:**	shp
	Description:	Coastal submerged aquatic vegetation (SAV)				
	Comment:	N/A				
SHELLFISH REEFS	**Coverage:**	DE		Online Location		
	Title:	*Delaware, New Jersey, and Pennsylvania Environmental Sensitivity Index Atlas*				
	Host:	OR&R, NOAA	**Year:**	2014	**Format:**	gdb
	Description:	Benthic habitats in Delaware, New Jersey, and Pennsylvania, including: SAV, algae, and shellfish.				
	Comment:	These habitats are included as part of the Biology INVERTEBRATES feature.				
SHELLFISH REEFS	**Coverage:**	MD, VA		Online Location		
	Title:	*Chesapeake Bay and the Outer Coasts of Maryland and Virginia*				
	Host:	OR&R, NOAA	**Year:**	2016	**Format:**	gdb
	Description:	Shellfish distribution in Chesapeake Bay and Maryland and Virginia coastal bays.				
	Comment:	These habitats are included as part of the Biology INVERTEBRATES feature. Data from a 2016 update is expected to become available in the coming months.				
SHELLFISH REEFS	**Coverage:**	NC		Online Location		
	Title:	*Estuarine Benthic Habitat Mapping*				
	Host:	NC DMF	**Year:**	2013	**Format:**	shp
	Description:	Shellfish-producing areas and delineated potentially productive benthic shellfish habitats.				
	Comment:	N/A				

Habitat	Data Resource					
NEARSHORE SOFT BOTTOM	**Coverage:**	DE, MD, VA, NC			Online Location	
	Title:	*Northwest Atlantic Marine Ecoregional Assessment - Benthic habitats*				
	Host:	TNC	**Year:**	2010	**Format:**	gdb
	Description:	Benthic habitats are combinations of Ecological Marine Units (depth, sediment grain size, and seabed forms) considered with their species assemblages.				
	Comment:	Data can be accessed from Chapter 3 - Benthic habitats				
NEARSHORE SOFT BOTTOM	**Coverage:**	NC			Online Location	
	Title:	*North Carolina Soft Bottom Habitats*				
	Host:	NCDMF	**Year:**	2015	**Format:**	shp
	Description:	Soft-bottom habitats from the NC Coastal Habitat Protection Plan				
	Comment:	N/A				

Appendix B: Additional Literature Resources

In addition to the literature cited in the white paper, the following literature was also reviewed as part of this effort:

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The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the sound use of our land and water resources, protecting our fish, wildlife and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island communities.

The Bureau of Ocean Energy Management

The Bureau of Ocean Energy Management (BOEM) works to manage the exploration and development of the nation's offshore resources in a way that appropriately balances economic development, energy independence, and environmental protection through oil and gas leases, renewable energy development and environmental reviews and studies.

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