Essential Fish Habitat Assessment for Commercial Wind Lease Issuance, Associated Site Characterization Activities and Subsequent Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore New Jersey, Delaware, Maryland, and Virginia

Bureau of Ocean Energy Management Regulation and Enforcement

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1.0 Introduction

The U.S. Department of the Interior (DOI) Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) proposes the issuance of offshore wind energy leases and approval of site assessment activities in the mid-Atlantic region of the Outer Continental Shelf (OCS). Pursuant to BOEMRE's regulations at 30 CFR Part 285, there are generally three phases of renewable energy development on the OCS: lease issuance, site assessment, and construction and operation of a renewable energy facility. A commercial and research renewable energy lease gives the lessee an exclusive right to apply for subsequent approvals that are necessary to advance to the next stage of the renewable energy development process. The second phase is BOEMRE review and approval of a site assessment plan (SAP) that allows the construction and installation of a meteorological tower and buoys (30 CFR 285.600; .605-.618). After the lessee has collected sufficient site characterization and assessment data the lessee may submit a construction and operation plan (COP), approval of which would authorize the actual construction and operation of a renewable energy facility (30 CFR 285.620-621). Although BOEMRE does not permit site characterization activities i.e., geological and geophysical surveys and core samples), a lessee must submit the results of such survey before BOEMRE can consider approving its COP (30 CFR 285.626). Therefore, site characterization surveys are a reasonably foreseeable result of lease issuance. This document is an assessment of the impacts to essential fish habitat, as designated through provisions of the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act), for proposed lease issuance, associated site characterization, and subsequent site assessment activities for siting of wind energy facilities in the mid-Atlantic OCS.

BOEMRE has the authority to issue OCS leases to Federal agencies and State agencies for renewable energy research activities that support the future production, transportation, or transmission of renewable energy (30 CFR 285.238). In issuing leases to a Federal agency or a State on the OCS for renewable energy research activities, BOEMRE will coordinate and consult with other relevant Federal agencies, any other affected State(s), affected local government executives, and affected Indian tribes. The Director and the head of the Federal agency or the Governor of a requesting State, or their authorized representatives, will negotiate the terms and conditions of such renewable energy lease on a case-by-case basis. The framework for such negotiations, and standard terms and conditions of such a lease, may be set forth in a memorandum of agreement (MOA) or other agreement between BOEMRE and a Federal agency or a State.

The proposed action is the issuance of commercial and research renewable energy leases within the Wind Energy Areas (WEAs) offshore New Jersey, Delaware, Maryland and Virginia, and approval of site assessment activities on those leases. In addition to this EFH Assessment, BOEMRE is developing a regional environmental assessment (EA) that will consider the environmental consequences associated with reasonably foreseeable site characterization scenarios associated with leasing (including geophysical, geotechnical, archeological and biological surveys), and reasonably foreseeable site assessment scenarios (including the installation and operation of meteorological towers and buoys) in the WEAs. This document incorporates by reference the Programmatic EIS for Alternative Energy Development and

Production and Alternate Use of Facilities on the Outer Continental Shelf (Programmatic EIS (MMS 2007b)), which gives greater detail of the affected environment including the life histories of the species outlined in this document.

Those companies applying to BOEMRE for leases would be responsible for applying for other applicable permits and/or authorizations. BOEMRE will make it a stipulation of its leases that the applicant must comply with all applicable laws. Although the consulting agencies may request a specific developer's SAP, it is not envisioned that there will be another opportunity to consult until the submittal and subsequent environmental review of the COP. Consultation may be reinitiated if warranted by specific circumstances.

2.0 EFH Assessment and Consultation History

The proposed activity is similar in many respects to the EFH consultation for Wind Resource Data Collection on the Northeast Atlantic Outer Continental Shelf (OCS) that was concluded on February 12, 2009 and in subsequent updates to that consultation in regards to the use meteorological buoys versus towers for individual projects. However, in contrast to individual lease blocks assessed in the previous consultation, this activity would encompass 4 "Wind Energy Areas" (WEAs) from New Jersey to Virginia composed of approximately 117 OCS lease blocks as opposed to 7 lease blocks off the coasts of Delaware and New Jersey as was the case previously. However, regarding the actual type of activity that would occur, there is little that has changed. The primary activities that would occur as part of the site characterization and assessment include: geological and geophysical surveys (sonar and sediment work), wind resource assessments (meteorological towers and buoys), biological assessments, and cultural/archeological assessments.

3.0 Proposed Action

3.1 Overview

The proposed action is the issuance of alternative energy leases, established under BOEMRE's Renewable Energy and Alternate Uses of Existing Facilities on the Outer Continental Shelf final rule (74 FR 19638, April 29, 2009). Specifically, the actions being evaluated as a part of this consultation are the issuance of a renewable energy lease and subsequent site assessment activities to aid in the siting of potential wind turbine generators in the mid-Atlantic OCS. The issuance of the lease does not constitute an irreversible commitment of the resources toward full development of the lease area. Thus this action is does not authorize, and the consultation does not evaluate, the construction of any commercial electricity generating facilities or transmission cables with the potential to export electricity.

The type of activities evaluated for this action includes, but is not limited, to the following:

- Geophysical and geotechnical (G&G) assessment.
  - Includes high resolution geophysical surveys (surface and subsurface seismic profiling, extent/intensity determined by the area being considered for development (primarily high to mid frequency sonar (i.e., side scan sonar, echo sounder, sub-bottom profilers). The use of airguns is NOT being considered as a part of this activity.

    - Geotechnical sub-bottom sampling (includes CPTs, geologic borings, vibracores, etc).
- Wind resource assessment
    - The construction of a meteorological towers
    - The installation of a LIDAR buoys
- Biological resource assessment
    - Presence/absence of threatened and endangered species
    - Presence/absence of sensitive biological resources/habitats
- Archaeological resource assessment
- Assessment of coastal and marine use

3.2 Description of Wind Energy Areas

On November 23, 2010, Secretary of the Interior Ken Salazar announced the "Smart from the Start" renewable energy initiative to accelerate responsible renewable wind energy development on the Atlantic Outer Continental Shelf (OCS) by using appropriate identified areas, coordinated environmental studies, large-scale planning and expedited approval processes. In the Notice of Intent (NOI) published on February 9, 2011 (76 FR 7226), BOEMRE, in consultation with other Federal agencies and State Renewable Energy Task Forces, identified WEAs offshore New Jersey, Delaware, Maryland, and Virginia. In 2010, BOEMRE began publishing Requests for Interest and Calls for Information for the areas below pursuant to 30 CFR 285.210-211 of the Competitive Lease Process. Those original WEAs in which BOEMRE proposed to begin the commercial lease issuance process and subsequent SAP approval process are detailed below and are the base for this assessment. However, it should be noted that the final area available for leasing will likely be a subset of the original WEAs as refined through the review and comment process outlined above. The original WEAs as detailed in the *Smart from the Start* initiative are as follows:

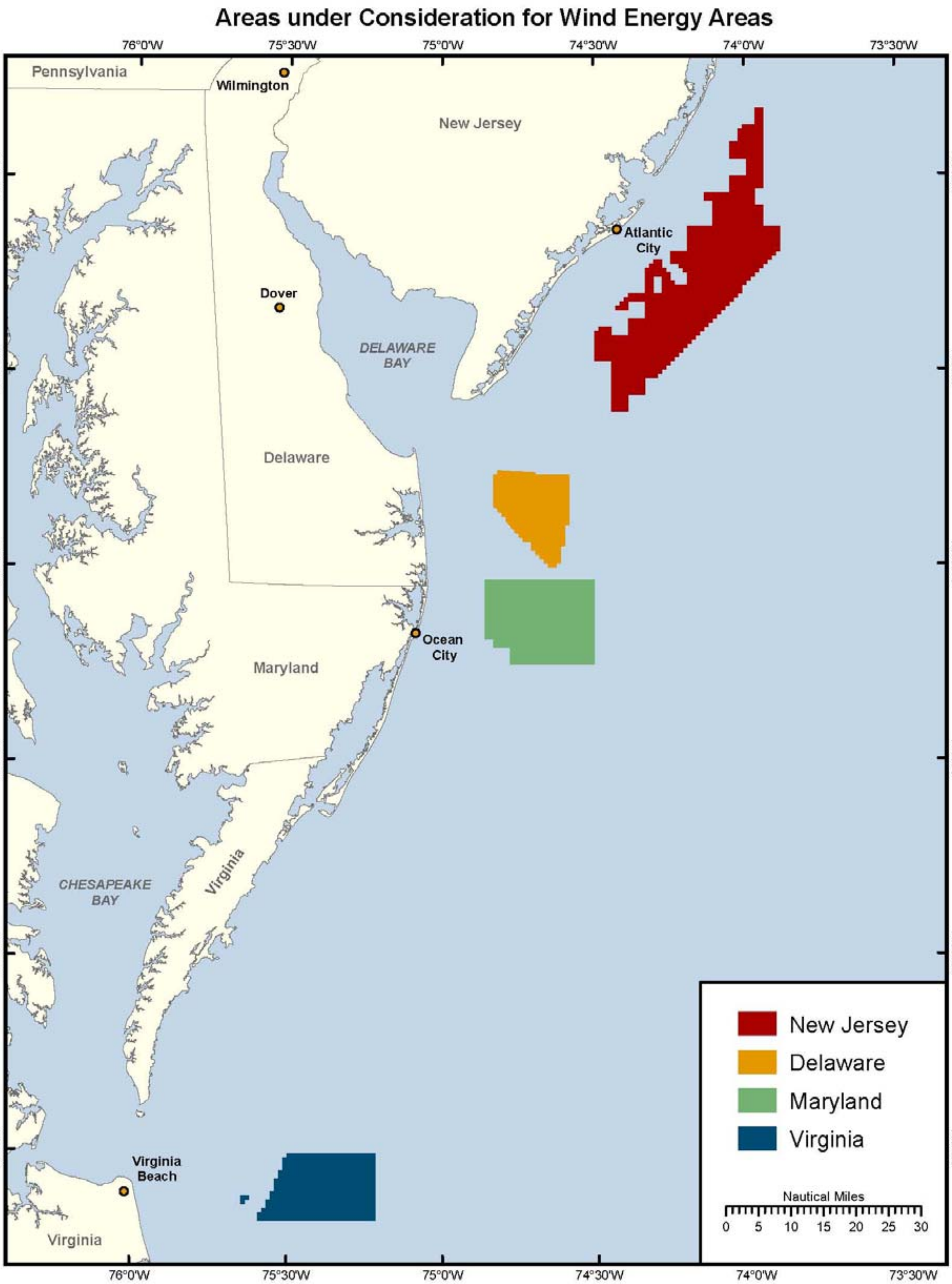
- *New Jersey*: The proposed area offshore New Jersey begins 7 nautical miles from the shore and extending roughly 23 nautical miles seaward (or the approximate 100 ft depth contour) and extends 72 nautical miles along the Federal/state boundary form Seaside Park south to Hereford Inlet. The entire area is approximately 420 square nautical miles; 356,104 acres, or 144,110 hectares, and contains approximately 43 whole OCS blocks and 34 partial blocks.
- *Delaware*: The proposed area offshore Delaware rests between the incoming and outgoing shipping routes for Delaware Bay, and is made up of 10 whole OCS blocks and 116 partial blocks. The closest point to shore is approximately 7.5 miles due east from Rehoboth Beach, Delaware. The entire area is approximately 122 square nautical miles, 103,949 acres, or 42,067 hectares.
- *Maryland*: The proposed area offshore Maryland is made up of 29 whole OCS blocks and 28 partial blocks. The western edge is approximately 10 nautical miles from the Ocean City, Maryland coast, and the eastern edge is approximately 27 nautical miles from the Ocean City, Maryland coast. The entire area is approximately 207 square nautical miles; 176,128 acres; or 71,276 hectares.
- *Virginia*: The proposed area offshore Virginia is made up of 22 whole OCS blocks and 41 partial blocks. The Western edge of the area is approximately 20 nautical miles from Virginia Beach, and the Eastern edge is approximately 37 nautical miles from Virginia

Based on the estimated sizes, the total for the mid-Atlantic WEAs is 915 square nautical miles, or approximately the size of the state of Rhode Island.

These are areas on the mid-Atlantic OCS that appear to have high wind resource potential and reduced multi-use conflicts. The key factors used to identify these WEAs include:

- Review of current technology and development patterns to account for technical feasibility of where development is likely to occur;
- The extent of available resource (technical and theoretical) for offshore wind based on the results of DOE study;
- Input from BOEMRE/State Task Forces;
- Feedback from consultation with federal and state authorities on current and possible future uses of the OCS; and
- Elements of the National Ocean Policy’s marine spatial planning efforts.

Figure 1


Areas under Consideration for Wind Energy Areas
76°0'W
75°30'W
75°0'W
74°30'W
74°0'W
73°30'W
39°30'N
39°0'N
38°30'N
38°0'N
37°30'N
37°0'N
Pennsylvania
Wilmington
New Jersey
Atlantic City
Dover
DELAWARE BAY
Delaware
Ocean City
Maryland
CHESAPEAKE BAY
Virginia
Virginia Beach
Virginia
New Jersey
Delaware
Maryland
Virginia
Nautical Miles
0 5 10 15 20 25 30

3.3 Site Characterization Surveys

Site characterization surveys include a variety of activities that assess construction hazards and characterize the physical, biological, cultural environment in which the project may take place. These activities would likely occur in spring and summer months when weather is usually calmer, however, surveys could potentially occur at anytime of year when weather permits. These activities are described below.

3.3.1 High-resolution Geological (HRG) Survey

The HRG data will provide information on all sub-seafloor conditions, shallow hazards, archaeological and cultural resources; and biological resources including sensitive benthic habitats. This information is used in the design construction and operations of met towers and future wind turbine placement to mitigate the potential impacts to installations, operations and production activities, and structure integrity. The scope of HRG surveys will be sufficient to reliably cover any portion of the site that may be affected by the renewable energy project's construction, operation, and decommissioning for the site assessment phase as well as the future commercial construction and operations phase. This includes the maximum Area of Potential Effect (APE) encompassing all seafloor/bottom-disturbing activities. The maximum APE includes but is not limited to the footprint of all seafloor/bottom-disturbing activities (including the areas in which installation vessels, barge anchorages, and/or appurtenances may be placed) associated with construction, installation, inspection, maintenance, removal of structures and/or transmission cables.

The geophysical survey grid(s) for project structures and the surrounding area would be oriented with respect to the bathymetry, shallow geologic structure, and renewable energy structure locations. The grid pattern for each survey would cover the maximum APE for all anticipated physical disturbances from construction and operation of a wind facility.

- Line spacing for all geophysical data for shallow hazards assessments (on side scan sonar/all sub-bottom profilers) will not likely exceed 150 meters throughout the APE.
- Line spacing for all geophysical data for archaeological resources assessments (on magnetometer, side scan sonar, chirp sub-bottom profiler) will not likely exceed 30 meters throughout the APE.
- Line spacing for bathymetric charting using multi-beam technique or side scan sonar mosaic construction may vary based on the water depths encountered but will provide both full-coverage of the seabed plus suitable overlap and resolution of small discrete targets of 0.5m - 1.0m in diameter.
- All track lines would run generally parallel to each other. Tie-lines running perpendicular to the track lines should not exceed a line spacing of 150 meters throughout the APE.

In addition, the geophysical survey grid for proposed transmission cable route(s) would include a minimum 300 meter-wide corridor centered on the transmission cable location(s). Line spacing would be identical to that noted above. These surveys would be conducted between the WEAs and shore.

3.3.1.1 HRG Survey Instrumentation

Table 1 gives a quick overview of the type of instrumentation that would be utilized during HRG Survey work in the mid-Atlantic WEAs.

Bathymetry/Depth Sounder: The depth sounder system would record with a sweep appropriate to the range of water depths expected in the survey area. BOEMRE encourages developers to use of a multi-beam bathymetry system particularly in areas characterized by complex topography or fragile habitats.

Magnetometer: Magnetometer survey techniques would be capable of detecting and aiding the identification of ferrous, ferric, or other objects having a distinct magnetic signature. The magnetometer sensor would be towed as near as possible to the seafloor but not exceed an altitude of greater than 6 meters above the seafloor. The sensor would be towed in a manner that minimizes interference from the vessel hull and the other survey instruments. The magnetometer sensitivity would be 1 gamma or less and that the background noise level would not exceed a total of 3 gammas peak to peak.

Sea Floor Imagery/Side Scan Sonar: Recording would be of optimal quality (good resolution, minimal distortion) resulting in displays automatically corrected for slant range, lay-back and vessel speed. Developers would likley use a digital dual-frequency side scan sonar system with preferred frequencies of 445 and 900 kHz and no less than 100 and 500 kHz to record continuous planimetric images of the seafloor. The data would be processed in a mosaic to provide a true plan view that provides 100 percent coverage of the APE. The side scan sonar sensor would be towed above the seafloor at a distance that is 10 to 20 percent of the range of the instrument.

The line spacing and display range would be appropriate for the water depth and the data obtained would be of such quality as to permit detection and evaluation of seafloor objects and features 0.5m – 1m in diameter within the survey area

Shallow & Medium (Seismic) Penetration Sub-bottom Profilers: A high-resolution "chirp" sub-bottom profiler would be used to delineate near-surface geologic strata and features. The sub-bottom profiler system would be capable of achieving a vertical bed separation resolution of at least 0.3 meters in the uppermost 15 meters below the mud-line.

For deeper seabed penetration a boomer profiler system may be necessary. It would be capable of penetrating greater than 10 meters beyond any potential foundation depth and the vertical resolution would be less than 6 meters. The seismic source would deliver a simple, stable, and repeatable signature that is near to minimum phase output with usable frequency content.

Table 1. Typical Equipment to be Utilized during HRG Survey

Survey Task	Example Equipment Model Type	Frequency (kilohertz)	Estimated Sound Pressure Levels at Source (dB re 1µPa RMS at 1m)
Singlebeam Depth Sounder	Innerspace Model 448	200 kHz	202 to 215 dB

Multibeam Depth Sounder	Reson 7101	240 kHz	207 dB
Side Scan Sonar	Klein Dual 3900	445 and 900 kHz	220 dB
Shallow-Penetration Subbottom Profiler (chirper)	EdgeTech chirper	2-16 kHz	201 dB
Medium-Penetration Subbottom Profiler (boomer)	Applied Acoustics boomer	0.5-20 kHz	205 dB

Although deep penetrating air guns, like those used in oil and gas exploration, are not part of the HRG survey or any of the actions being analyzed herein, the noise information for that technology is noted here as a reference for reviewers. According to the Gulf of Mexico G&G Environmental Impact Stsatement (MMS 2004), airguns used in high-resolution site surveys range from 229 dB re 1 μPa at 1 m with a frequency from 0.4 to 3 kHz to 226 dB re 1 μPa at 1 m. Table 1 above gives a list of typical equipment and their acoustic intensity.

The Cape Wind Energy Project on Horseshoe Shoal off the coast of Massachusetts, being the only permitted offshore wind facility in the U.S., is often used as a source for site assessment and construction information. Analysis for HRG survey work conducted for Cape Wind for their project indicated that HRG survey noise dissipated to 180 dB at 16 meters from the source for the chirp and 27 meters for the boomer. Underwater sound levels dissipated to 160 dB isopleths at 227 meters from the source for the chirp and underwater sound levels from the boomer dissipate to 160 dB at 386 meters from the source. However, it should be noted that this information serves as a guide and that different equipment may produce different results in different sub-marine environments. For general discussion purposes the area of ensonification has been conservatively rounded up to 30m and 400m for the boomer at 160dB and 180dB respectively. Section 8.0 details mitigation and monitoring required during HRG survey work.

3.3.1.2 Proposed HRG Survey Action Scenario

It is assumed that the HRG survey would use the finer line spacing required for archaeological resource assessment (30 meters). Tie-lines would be run perpendicular to the track lines at a line spacing of 150 meters. This results in 767 miles of HRG surveys per lease block (lease block is 3nm x 3nm). At 4.5 knots, it would take approximately 150 hours to survey one lease block. Surveying a 300 meter-wide corridor along a potential cable route located outside of a WEA would result in about 5 miles or 1 hour of surveys per mile of cable. In order to survey the entire WEAs and potential cables, HRG surveys would have to be conducted by multiple vessels and/or over multiple years and potential cable routes. Based on these assumptions and one cable route per potential commercial wind facility, the proposed action would result in the following length or duration HRG surveys:

Table 2. Proposed Site Assessment Action Scenario

Wind Energy Area (WEA)	High-resolution Geophysical (HRG) Surveys (max miles/hours)	Sub-bottom Sampling Locations (min-max)	Meteorological Towers (max)	Meteorological Buoys (max)
New Jersey	35,000/6,700	650-2,050	4	8
Delaware	14,000/2,600	250-800	0	0
Maryland	24,000/4,600	450-1,400	3	6
Virginia	19,000/4,000	350-1,100	3	6

3.3.2 Biological Resource Survey

The sub-marine biological survey will primarily be limited to the delineation of bottom features such as submerged aquatic vegetation and other live bottom features. These features will likely be detected with side scan sonar equipment and then groundtruthed with camera equipped remotely operated vehicles (ROVs) and/or human divers. Shipboard observers would monitor and document sitings of marine mammals and sea turtles when at the surface. The various remote sensing activity used in the biological resource survey will likely occur simultaneously with the HRG survey activity and is thus not repeated here. Surface and aerial biological resources (e.g. birds and bats) would likely be assessed via shipboard observers during the HRG survey and via monitoring equipment affixed to the met buoys or towers.

3.3.3 Cultural Resource Survey

To locate archaeological and cultural resources, and other metallic debris a magnetometer survey would be conducted using one of three types of sensors: An Overhauser effect sensor, a proton precession sensor, or a cesium vapor sensor. An archaeological survey is required by the National Historic Preservation Act of 1966, as amended, when you propose bottom-disturbing activities in areas that the BOEMRE has identified as having a potential for containing historic or prehistoric archaeological resources. If an archaeological survey is required, survey lane spacing of no more than 30 m (100 ft) shall be used according to the lease. The various remote sensing activity used in the cultural resource survey will likely occur simultaneously with the G&G activity and is thus not repeated here.

3.3.4 Sub-Bottom Reconnaissance

Sub-bottom reconnaissance refers to site specific geologic profiles. Typically these use cone penetrometer tests (CPT) or sediment borings/drillings taken at the proposed foundations of wind turbines and met towers. The principal purpose of this work is to: (1) assess the suitability of shallow foundation soils to support the renewable energy structure or associated transmission cable under extreme operational and environmental conditions that might be encountered, and (2) document soil characteristics necessary for design and installation of all structures and transmission cables. Vibracores may be taken when there are known or suspected archaeological/and or cultural resources present (identified through the HRG survey or other work) or for some limited geological sampling.

Vibracores would likely be advanced from a small (less than 45 feet) gasoline powered vessel. The diameter of a typical vibracore barrel is approximately 4 inches and the cores are advanced up to a maximum of 15 feet. Deep borings would be advanced from a truck-mounted drill rig placed upon a jack-up barge that rests on spuds lowered to the seafloor. Each of the four spuds would be approximately 4 feet in diameter, with a pad approximately 10 feet on a side on the bottom of the spud. The barge would be towed from boring location to location by a tugboat. The drill rig would be powered using a gasoline or diesel powered electric generator. Crew would access the boring barge daily from port using a small boat. Geologic borings generally can be advanced to the target depth (100 to 200 feet) within 1 to 3 days, subject to weather and substrate conditions. Drive and wash drilling techniques would be used; the casting would be approximately 6 inches in diameter. The CPT or an alternative subsurface evaluation technique would supplement or be used in place of deep borings. A CPT rig would be mounted on a jack-up barge similar to that used for the borings. The top of a CPT drill probe is typically up to 3 inches in diameter, with connecting rods less than 6 inches in diameter

Environmental considerations for sub-bottom reconnaissance center around benthic habitat disturbance from anchoring vessels and boring activity and from acoustic impacts from boring. It is envisioned that the majority of work will accomplished via CPT which does not require deep borehole drilling. However, some geologic conditions may prevent sufficient data from CPTs and require obtaining a geologic profile via a borehole. Acoustic impacts from boring are expected to be below the 160 dB threshold established by NMFS for marine mammal harassment. Previous estimates submitted to BOEMRE for geotechnical drilling have source sound levels at around 118-145dB at a frequency of 120Hz (NMFS 2009).

3.3.4.1 Sub-bottom Reconnaissance Scenario

As discussed in the Programmatic EIS (MMS 2007b), spacing between turbines is typically determined on a case-by-case basis to minimize wake effect and is based on turbine size and rotor diameter. In Denmark's offshore applications, a spacing of seven rotor diameters between units has been used. The Cape Wind project proposed a spacing of 6 x 9 rotor diameters. In some land-based settings, turbines are separated by as much as 10 rotor diameters from each other. Based on this range in spacing for a 3.6 MW (110 meter rotor diameter) turbine and a 5 MW (130 meter rotor diameter) turbine, it would be possible to place 14 – 45 turbines in one OCS block (3nm x 3nm). Assuming that a sub-bottom sample (vibracore, CPT and/or deep boring) would be conducted at every potential turbine location, one can calculate the number of ground penetrating surveys could occur as a result of the proposed action (assuming 100% coverage of WEA with 14 – 45 turbines per block). Based on this assumption, a rotor diameter range of 110 – 130 meters, and the WEA size, the proposed action would result in the number of sub-bottom sampling surveys detailed below. The following number of ground penetrating surveys could occur as a result of the proposed action:

- New Jersey: 650 – 2,050 sub-bottom sample.
- Delaware: 245-780 sub-bottom samples.
- Maryland: About 430-1,385 sub-bottom samples.
- Virginia: About 345-1,105 sub-bottom samples.

However, it should be noted that BOEMRE may only require a portion of the turbine location sub-bottom samples per project prior to submission of the project's COP. Thus it is likely that this effort could be spread out over a period that exceeds that under the SAP.

3.3.5 Site Assessment

"Site assessment" describes the assessment of the wind resource via the installation of permanent to semi-permanent meteorological towers and buoys. Prior to submitting a construction and operation plan (COP), data would need to be collected on wind resource characteristics and potential. To determine whether a site is appropriate for a wind turbine facility, a meteorological tower or buoy would be installed in the area of the proposed facility to measure wind speeds and to collect other relevant data necessary to assess the viability a potential commercial wind facility.

The following scenario is intended to be broad enough to cover the range of data collection devices that would be submitted under SAPs and is based upon applications received under interim policy leases for site assessements. The actual tower and foundation type and/or buoy type and anchoring system would be included in a detailed SAP submitted to BOEMRE after site characterization surveys of the immediate area are conducted and prior to installation of device(s). In addition to LIDAR (light detecting and ranging) technology for collecting wind resource data, buoys and/or bottom-founded structures could use SoDAR (Sonic Detecting and Ranging) and CODAR Coastal Ocean Dynamic Applications Radar) technologies. Alternative platforms to buoys and met towers described in the sections below include: Gravity-base towers and various floating platforms (e.g. tension leg floating platforms, jack-up barges, anchored barges). The specific technologies described below captures the range of technologies and associated impacts. BOEMRE will review individual SAPs submitted to the Agency to determine if a supplemental NEPA analysis and/or re-initiation of relevant consultations are required.

Meteorological towers and buoys may also be authorized by the ACOE under a Nationwide Permit 5, Scientific Measurement Devices.

3.3.5.1 Proposed Action Scenario

It is assumed that each potential commercial wind facility would result in 0-1 meteorological towers, 0-2 buoys, or a combination. Based on the minimum size of a commercial wind facility and the layout of the WEAs, the following data collection facilities are projected as a result of the proposed action:

- New Jersey WEA: Up to four meteorological towers and eight meteorological buoys. Three leases have already been issued under BOEMRE's interim policy. Those data collection facilities were not included in the proposed action scenario, but are included in the cumulative analysis.
- Delaware: Limited meteorological monitoring devices are anticipated due to previously permitted activity under an interim policy lease, therefore only one met buoy is considered.
- Maryland WEA: Up to three meteorological towers and 6 meteorological buoys.
- Virginia WEA: Up to three meteorological towers and six meteorological buoys.

Case Study: Cape Wind Meteorological Tower

The only meteorological tower currently installed on the OCS is located on Horseshoe Shoal in Nantucket Sound (Figure 4). In 2002, the U.S. Army Corps of Engineers (USACE) prepared an EA for the Cape Wind meteorological tower (USACE, 2002). The USACE found that "based on the evaluation of environmental effects discussed in this document, the decision on this application is not a major federal action significantly affecting the quality of the human environment. Hence, an environmental impact statement is not required." The tower was installed in 2003 and consists of three pilings supporting a single steel pile that supports the deck. The overall height of the structure is 60 m (197 ft) above the mean lower low water datum. The Cape Wind meteorological tower represents the smaller end of the range of structures anticipated in the mid-Atlantic. It is located in shallower water (2.4 to 3m; 8 to 10 ft) and nearer to shore (approximately 9.7 km; 6 mi) than the mid-Atlantic WEAs.

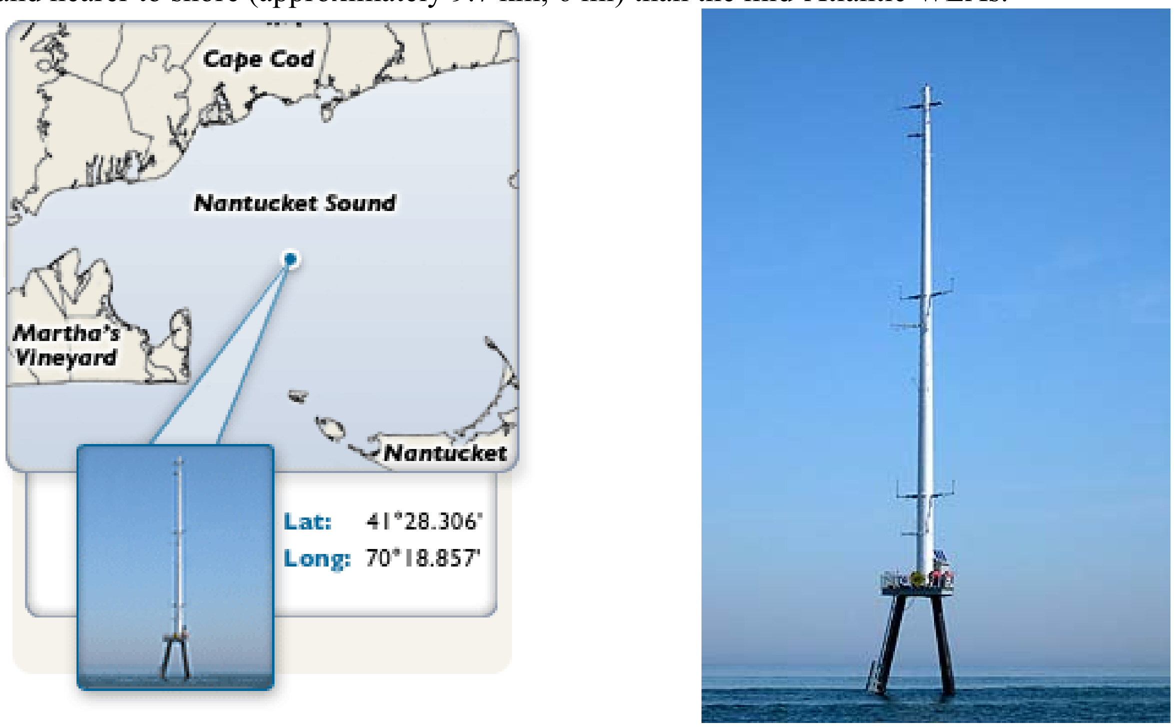


Figure 2. Cape Wind Meteorological Tower. Source: Cape Wind Associates, LLC.

3.3.5.2 Meteorological Tower

As detailed in the Cape Wind Energy example, one type of component used for evaluating offshore wind resources is the meteorological tower (met tower). At a maximum, a single met tower would be installed per total lease area (it is estimated that a minimum viable lease area would include 6 lease blocks), approximately 54 square miles. The foundation structure and scour control system, if necessary, would occupy a very small portion of the lease area (less than two acres). Once installed the top of the met tower would be approximately 90 to 100 m (295 to 328 ft) above mean sea level, or the anticipated height of the wind turbines's nacelle for that specific area.

A met tower consists of a mast mounted on a foundation anchored to the seafloor. The mast may be either a monopole or a lattice (same as a radio tower). A monopole mast was used for the Cape Wind met tower. Examples of lattice mast are shown on Figures 3 and 4. The mast and data collection devices would be mounted on a fixed or pile-supported platform (Figures 2-4). A deck would be supported by a single 10-foot-diameter monopole, tripod, or a steel jacket with three to four 36-inch-diameter piles (Figures 2-4). The monopole or piles would be driven about

7.6 to 13.7 m (25 to 45 ft) into the seafloor. The area of ocean bottom affected by the meteorological tower would range from about a couple hundred square feet if supported by a monopole to a couple thousand square feet if supported by a jacket foundation.

To obtain meteorological data, scientific measurement devices, consisting of anemometers, vanes, barometers, and temperature transmitters, would be mounted either directly on the tower, or on instrument support arms extending out approximately 3 m (10 ft). These devices may be located at three or four levels along the meteorological tower.

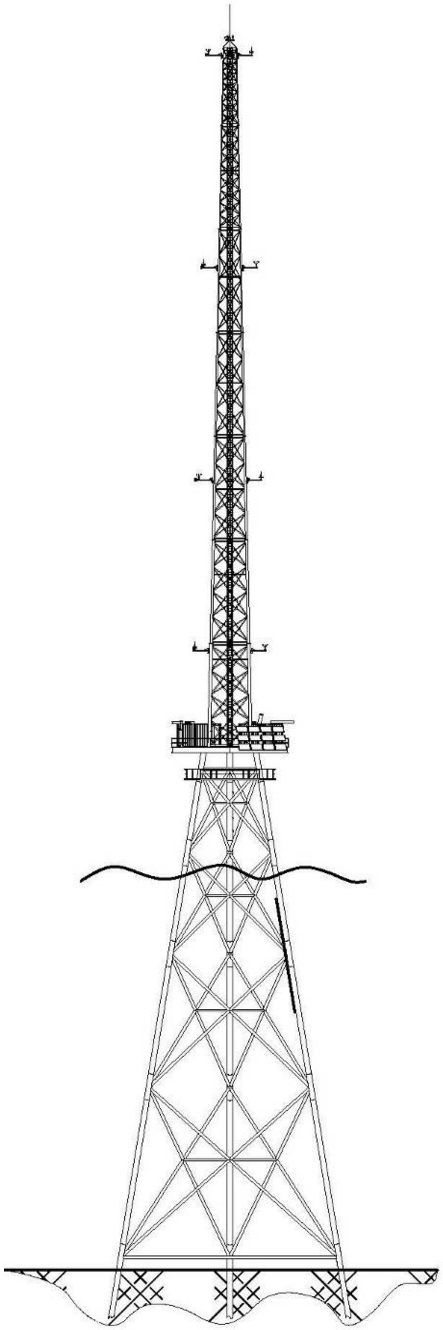


Figure 3. Example of a Lattice-type Mast Mounted on a Steel Jacket Foundation.
Source: Deepwater Wind, LLC.

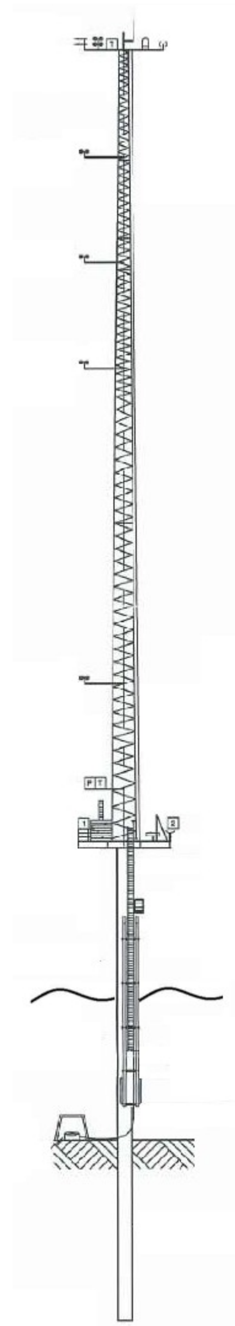


Figure 4. Example of a Lattice-type Mast Mounted on a Monopile Foundation.
Source: Fishermen's Energy of New Jersey, LLC.

Scour Control Systems
Due to the potentially high energy oceanic environment of the mid-Atlantic WEAs, scour control systems will likely be necessary for met tower foundations. There are several methods for mitigating the effects of ocean sediment scour around met tower foundations, which include placement of rock armoring and mattresses of artificial (polypropylene) seagrass (Figure 5).

The most likely scour control system that would be used for the proposed met towers would be artificial seagrass mats, which have found to be effective in shallow and deep water (ESS Group, Inc. 2003). These mats are made of synthetic fronds that mimic seafloor vegetation to trap sediment and become buried over time. These mats would be installed by a diver or remotely operated vehicle (ROV). Each mat would be anchored at 8 to 16 locations, about one foot into the sand. Once installed the mats would not require future maintenance. Depending on the water depth, the buoyant fronds would be 0.625 to 1.25 m (2.0 to 4.1 ft) tall. The fronds would build up sand about 0.3 to 1 m (1 to 3 ft) in height within one year. Based on the manufacturer's information, the sand sediment bank would extend out 1.8 to 2.2 m (5.9 to 7.2 ft) (Seabed Scour Control Systems Ltd., 2008). Monitoring of scouring at the Cape Wind Meteorological Tower found that at the pile where two scour mats were previously installed there was a net accretion of 30.5 cm (12 in) of sand (Ocean and Coastal Consultants, Inc. 2006). Around the pile where no previous scour mats were installed there was a net scour of 17.8 cm (7 in).

It is estimated for a pile-supported platform four mats each about 5 by 2.5 m (16.4 by 8.2 ft) would be placed around each pile (Figure 6). Including the extending sediment bank, a total area disturbance of about 1584.9 to 1798.3 square meters (5,200 to 5,900 square feet) for a three-pile structure and 1798.3 to 2377.4 square meters (5,900 to 7,800 square feet) for a four-pile structure is estimated. For a monopole, it is estimated that eight mats about 5 by 5 meters (16.4 by 16.4 feet) would be used, and there would be a total area disturbance of about 1127.8 to 1219.2 square meters (3,700 to 4,000 square feet). Figure 6 gives possible configurations of artificial sea mats.

Removal of the scour control system is discussed in Section 3.6.2, Removal of Scour Control System.


Figure 5. Source: Seabed Scour Control Systems Ltd.

The armor stones used in a rock armor scour protection would be sized so that that they are large enough not to be removed by the effects of the waves and currents, while being small enough to prevent the stone fill material placed underneath it from being removed. Rock armor and filter layer material would be placed on the seabed using a clamshell bucket or a chute.

Although the seafloor in mid-Atlantic WEAs are greater than 15 feet from the surface, rock armor analysis for the Cape Wind project illustrates a range of the rock weight and footprint for this type of armoring. The Cape Wind project determined that met towers located in shallow water (less than 15 feet) would be subject to higher wave-induced velocities, so the armor stone size would be larger and armor stone layer thickness would be thicker (ESS Group, Inc., 2006). In water depths less than 15 feet, the median stone size would be about 125 pounds with a stone layer thickness of about four feet. In water depths greater than 15 feet, the median stone size would be about 50 pounds with a stone layer thickness of about three feet. It is estimated that the rock armor would impact 16,000 square feet (0.37 acres) of the seabed.

The scour control system would be monitored throughout the lease term. The foundation should be visually inspected monthly for the first year of installation, and then every year after that or after significant storm activity. Inspections would be carried out by divers or ROV's.

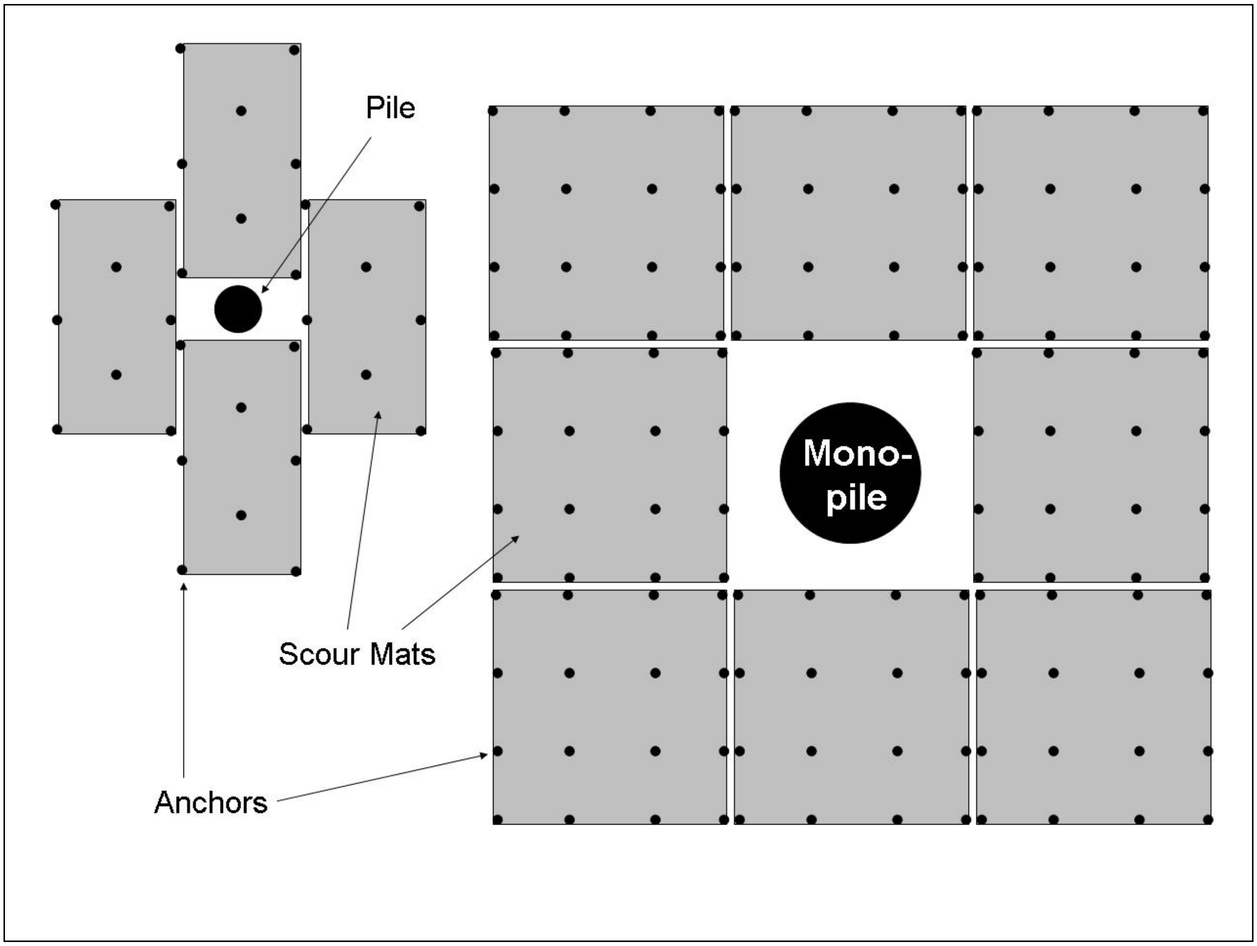


Figure 6. Examples of a scour control layouts.

Installation of the Foundation Structure

If a fixed platform is used, the jacket foundation and deck would be fabricated onshore then transferred to barge(s) and towed to the offshore site. This equipment will be deployed from two barges, one containing the pile driving equipment and a second containing a small crane, support equipment and the balance of materials needed to erect the platform deck. These barges will be tended by appropriate tugs and workboats as needed.

The foundation pile(s) for the fixed platform could range from either a single 3.05 m (10 ft) diameter monopole to four 0.91 m (3 ft) diameter piles. These piles would be driven about 7.6 to 13.7 m (25 to 45 ft) below the seafloor with a pneumatic piledriving hammer typically used in marine construction operations. When the pile driving is complete after approximately three days, the pile driver barge will be removed. In its place a jack-up barge equipped with a crane may be utilized to assist in the mounting of the platform decking, tower and instrumentation. The in-water construction time of the foundation pilings and platform will be approximately six weeks and the total time of installation on site will be a few days to six weeks.

The following information on pile driving was taken from Hanson et al. (2003). Piles are usually driven into the substrate using one of two types of hammer: impact hammers and vibratory hammers. Impact hammers consist of a heavy weight that is repeatedly dropped onto the top of the pile, driving it into the substrate. Vibratory hammers utilize a combination of a stationary, heavy weight and vibration, in the plane perpendicular to the long axis of the pile, to force the pile into the substrate. The type of hammer used depends on a variety of factors, including pile material and substrate type. Impact hammers can be used to drive all types of piles, while vibratory hammers are generally most efficient at driving piles with a cutting edge (e.g., hollow steel pipe) and are less efficient at driving "displacement" piles (those without a cutting edge that must displace the substrate). Displacement piles include solid concrete, wood, and closed-end steel pipe. While impact hammers are able to drive piles into most substrates (including hardpan, glacial till, etc.), vibratory hammers are limited to softer, unconsolidated substrates (e.g., sand, mud, gravel). Since vibratory hammers do not use force to drive the piles, the bearing capacity is not known and the piles must often be "proofed" with an impact hammer. This involves striking the pile a number of times with the impact hammer to ensure that it meets the designed bearing capacity. Under certain circumstances, piles may be driven using a combination of vibratory and impact hammers. The vibratory hammer makes positioning and plumbing of the pile easier; therefore, it is often used to drive the pile through the soft, overlying material. Once the pile stops penetrating the sediment, the impact hammer is used to finish driving the pile to final depth. An additional advantage of this method is that the vibratory hammer can be used to extract and reposition the pile, while the impact hammer cannot. Overwater structures, such as the meteorological towers, must often meet seismic stability criteria, requiring that the supporting piles are attached to, or driven into, the underlying hard material. This requirement often means that at least some impact driving is necessary.

During installation, a radius of about 457.2 m (1,500 ft) around the site would be needed for the movement and anchoring of support vessels. A number of vessel trips to and from the onshore staging area would occur during installation. Depending on the foundation type used installation would take 8 days to 10 weeks.

Foundation Hammering Sounds

The type and intensity of the sounds produced during pile driving depend on a variety of factors, including, but not limited to, the type and size of the pile, the firmness of the substrate into which the pile is being driven, the depth of water, and the type and size of the pile-driving hammer. Sound pressure levels are positively correlated with the size of the pile, as more energy is required to drive larger piles. Wood and concrete piles appear to produce lower sound pressures than hollow steel piles of a similar size. Firmer substrates require more energy to drive piles, and produce more intense sound pressures. Sound attenuates more rapidly with distance from the source in shallow than in deep water (Rogers and Cox 1988).

Driving hollow steel piles with impact hammers produce intense, sharp spikes of sound, while vibratory hammers produce continuous sound of lower intensity. When compared to impact hammers, the sounds produced by vibratory hammers are of longer duration (minutes vs. msec) and have more energy in the lower frequencies (15 to 26 Hz vs 100 to 800 Hz) (Würsig, et al. 2000, Carlson et al. 2001). Impact hammers, however, produce such short spikes of sound with little energy in the infrasound range (Carlson et al. 2001). Impact hammers produce more intense pressure waves than vibratory hammers. The environmental impacts of this sound production is discussed further in Section 4.

Met Tower Operation and Maintenance Activities
Depending on the duration of HRG survey, BOEMRE's review of the SAP, and construction, the proposed structure would likely be present for 4 to 5 years. The developers must submit a COP no later than 5 years after the issuance of the lease. At that time, BOEMRE will evaluate the proposed extension of the met tower.

Met Tower Lighting
Aviation and navigation safety lighting would be installed and maintained on the structure in accordance with FAA and USCG requirements. The USCG lighting for navigation safety would consist of two amber lights (USCG Class C) mounted on the platform deck. In accordance with FAA guidelines, the tower would be equipped with a light system consisting of a low intensity flashing red light (FAA designated L-864) for night use. The project developers would also be required to follow Private Aids to Navigation (PATON) requirements of the USCG. Lighting is further discussed in Sections 4 and 7.

Met Tower Inspections
As would be required by the lease, the project developer must allow prompt access to any authorized Federal inspector to the site of any activities conducted pursuant to the lease. These inspections may include annual scheduled inspections and periodic unscheduled (unannounced) inspections to assure compliance with the lease and applicable regulations.

3.3.5.3 Meteorological Buoys

Due to the construction costs of installing a met tower offshore, more developers are looking to lower cost alternatives to evaluate the wind resource in the lease areas. The primary alternative is meteorological buoys (met buoys). These met buoys, of varying designs, utilize Light Detection and Ranging (LIDAR) and/or Sonic Detection and Ranging (SODAR). These may be used instead of or in addition to anemometers to obtain metrological data. LIDAR is a surface-based remote sensing technology that operates via the transmission and detection of light. SODAR is also a surface-based remote sensing technology, however operates via the transmission and detection of sound.

Spar Buoy Design
One buoy design that is under consideration by developers is called a spar buoy. A spar buoy is a long, thin, typically cylindrical buoy, ballasted at one end so that it floats in a vertical position. This design maintains tension in the anchor chain between the buoy and the anchor, thus eliminating slack in the chain that results in chain sweep around the anchor. One such buoy is the SeaZephIR™ (Figure 7) buoy proposed for use by Deepwater Wind/Garden State Offshore Energy (GSOE) off the New Jersey coast. The following description of the buoy and installation is from GSOE's SAP submitted under their IP lease (GSOE 2010).

The Sea ZephIR™ is a floating spar buoy platform approximately 100 feet in total length and approximately 6 feet in diameter. The Sea ZephIR™ superstructure is designed for deployment in harsh marine conditions while offering maximum stability through the use of an on-board ballasting mechanism that will reach approximately 60 feet below the ocean surface. Approximately 30-40 feet of the Sea ZephIR™ will be above the ocean surface. This portion of the Sea ZephIR™ will house the LIDAR equipment, power sources (battery and wind micro-turbines), passive acoustic monitoring systems.

The buoy will be moored to the ocean floor via a single clump weight anchor that consists of a reinforced concrete pad approximately 22 feet x 22 feet x 3 feet in size and weighing approximately 100 tons. A main mooring line, safety line and yaw stabilizer line will be connected from the clump weight anchor to the base of the buoy.

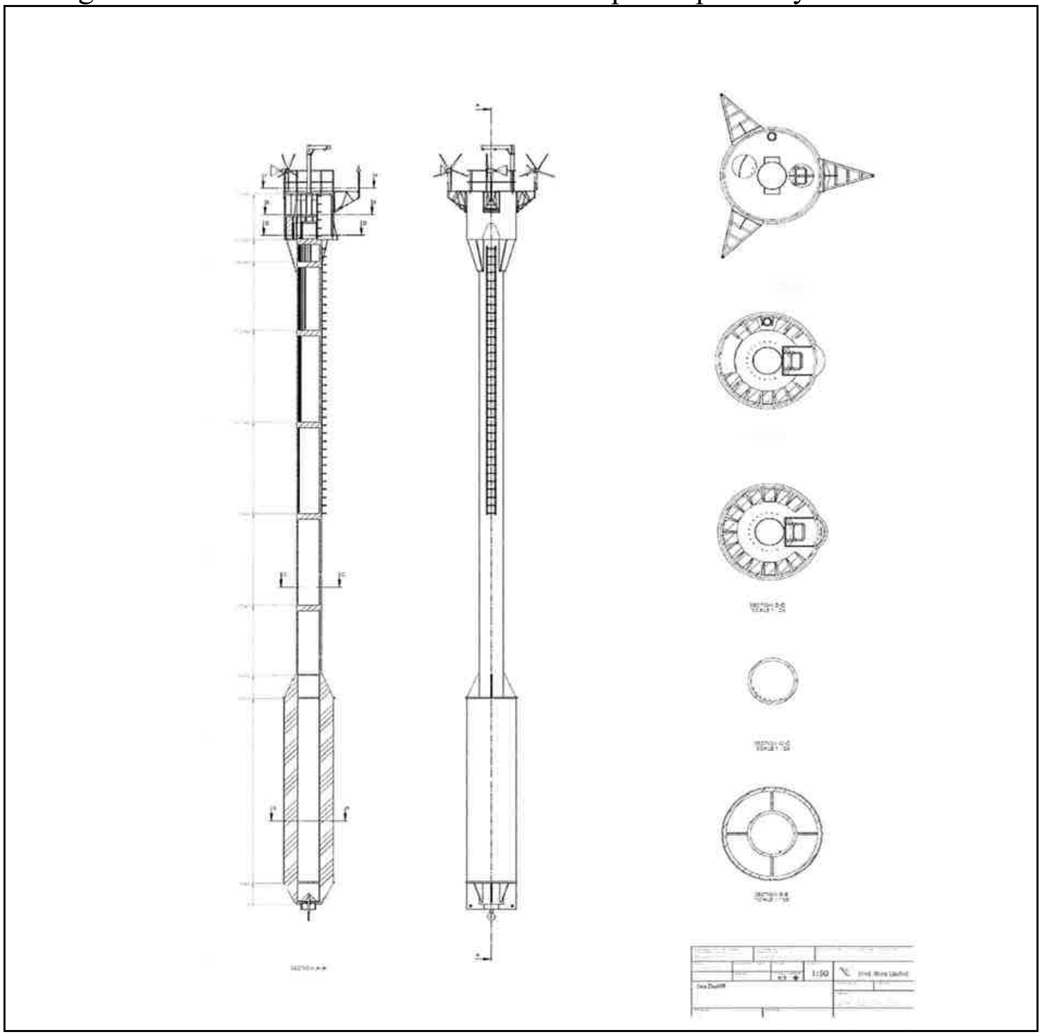
The ballast system used by the Sea ZephIR™. The water capacity is 15.2 metric tons, roughly 4,000 gallons of seawater assuming 8.5lbs of seawater per gallon. The time to fill the ballast hold is approximately 4 hours. A barge mounted salt water pump with an industrial screen mesh would be used to fill the tank. The intake velocities of pump is estimated to be 0.6fps (assumed pumping rate of 16gpm). The intake to industrial pump would be via a 3" diameter suction hose located approximately 3 to 4 feet below mean sea level.

An analysis of the 100-year storm wind, tide, wave, and current characteristics and a structural analysis of the spar buoy design have been conducted to ensure that the Sea ZephIR™ can withstand the potential worst-case sea conditions at the site.

Sea ZephIR™ Installation
The concrete clump weight anchor would be loaded onto a work barge and sea fastened to the barge deck. The barge will then be towed to the deployment site. Once on site the barge will be anchored with the aid of an assist tug and the clump weight anchor will be lowered, under control, to the sea floor. Once on the seabed, the position of the anchor will be noted and a small marker buoy will remain in place connected to the anchor.

After the first phase is completed, the spar buoy will be towed in the horizontal plane by a tug to the deployment site. A work barge equipped with a 4-point mooring system, a crane, a sea water pump system and a dive station will also be towed to the deployment site by a tug. Once at site the work barge will anchor over the clump weight position. Once the barge is fast to its mooring the spar buoy will be maneuvered alongside the barge. The water pump system will be used to fill a system of ballast tanks integral to the buoy assembly. The ballast operation will re-align the buoy from the horizontal plane to a vertical position. Once vertical the buoy will be held on station at the anchored barge while a dive team attaches the mooring chain to the clump weight anchor. Once moored in position the meteorological test equipment will be fitted to the buoy. With the buoy in the vertical position and the meteorological equipment in place the work barge anchors will be recovered and the barge and tugs will depart the site.

Figure 7. Elevation schematic of the SeaZephIR spar buoy



Other Met Buoy Designs

Another buoy design that could be utilized to mount a LIDAR wind assessment system is of the NOMAD (Navy Oceanographic Meteorological Automatic Device) hull. The NOMAD is a 6 x 3.1m aluminum hulled buoy with a draft of 3.2m. Originally designed by the U.S. Navy in the 1940s, the NOMAD has since been adopted and widely used by researchers, including NOAA's National Data Buoy Center. The following description is from Fishermen's Energy SAP (FERN 2011).

Primary electrical (DC) power for all equipment on this type of buoy could be provided by four deep cycle 12 volt batteries. Batteries will be charged by renewable sources which include (2) wind generators and (4) 40-watt solar panels. In the event that the renewable power sources fail to keep the batteries adequately charged (extended heavy cloud cover with little wind), the power monitoring system could prompt an onboard diesel fuel powered generator to start and run until the batteries reach the required charge level. The system would revert back to renewable charging once these systems return to proper operation (FERN 2011). Up to 500 gallons of diesel fuel could be stored on board the buoy to operate the generator.

The anchoring system for this type of buoy would be a via a standard ¾ " steel chain to a 6000 lb steel block. The footprint of the anchor itself is conservatively estimated at 6 ft^2. Fishermen's Energy conservatively estimates the total bottom-disturbing footprint from the anchor and anchor chain sweep at low tide to be 371,000ft^2 or 8.51 acres (approximately 100ft of slack chain at low tide).

Because of its size, a buoy of the NOMAD design would likely be towed by a single vessel to the site in the lease area at speeds of around 3 knots. Although U.S. Coast Guard buoy tending vessels greater than or equal to 180' are known to be able to transport and deploy a buoy of this size from it's deck, a wind developer may not have access to a vessel of this size.

Other Ocean Monitoring Equipment

Additional buoys and/or other instrumentation will likely be installed on or near the primary met tower or met buoy to monitor oceanographic parameters and to collect baseline information on the presence of certain marine life. Environmental monitoring equipment such as avian monitoring equipment, sub-marine passive acoustic monitors, data logging computers, power supplies, communications equipment, material hoist, and storage containers may be included.

For some devices a tethered buoy would monitor ocean environmental parameters (sea surface and ocean profile) along with marine mammal activities. The buoy could be located near the met tower or buoys or moved throughout the lease area during the site assessment period. Buoy size is estimated to be up to 2.7 m by 2.7 m (9 ft by 9 ft) (Figures 8 and 9). The area of disturbance from a chain sweep would likely be similar to that described above a 8.51 acres per buoy.

Figure 8. Ocean Monitoring Buoy Deployment. Source: Deepwater Wind, LLC.

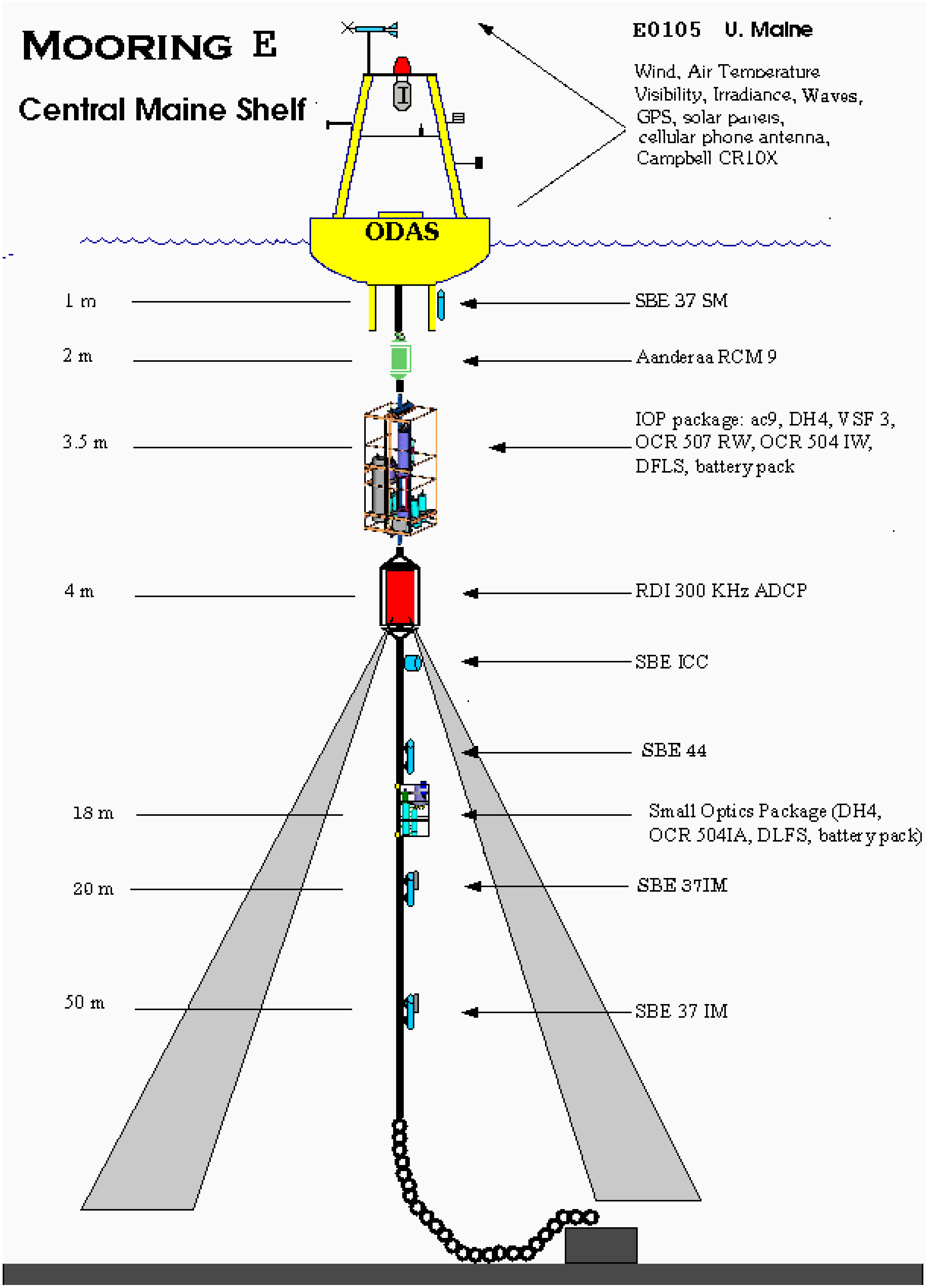


Figure 9. Example of an Ocean Monitoring Buoy. Source: Deepwater Wind, LLC.

To measure the speed and direction of ocean currents, one to two acoustic doppler current profilers (ADCPs) may be installed with each met tower or buoy as part of the mooring system or structure (Figure 10). The ADCP works by transmitting "pings" of highly pitched sound at a constant frequency into the water. As the sound waves travel, they ricochet off fine particles or zooplankton suspended in the water column, and reflect back to the ADCP. The difference in frequency between the waves the ADCP sends out and the waves it receives is called the Doppler shift. The ADCP's may be mounted on the seafloor or to the legs of the platform. A seafloor-mounted ADCP would be located near the meteorological tower (within 150 m (500 ft)) and be connected by a wire that is hand buried into the ocean bottom. A typical ADCP has 3 to 4 acoustic transducers that emit and receive acoustical pulses from 3 to 4 different directions. Frequencies would range from 300 to 600 kHz with a sampling rate of 1 to 60 minutes. The width of the ADCP would be about 0.3 to 0.6 m (1 to 2 ft), and its mooring, platform or cage would be several feet wider.

Figure 10. Examples of ADCP's although actual deployment would differ from that pictured above (see description in text).

3.3.5.4 Timing of Wind Resource Assessment Equipment Installation

Installation of met towers and buoys would likely occur in the spring and summer months with calmer weather, however, installation could potentially occur at anytime of year when weather permits. Total installation time of one meteorological tower would take eight days to ten weeks. It is anticipated that the installation of a met buoy would likely take 1-3 days.

3.4 Vessel Traffic

Vessel traffic, both by air and by sea, occurs during all phases of the site characterization and assessment activities. Vessel traffic is included in this assessment as it could potentially decrease the quality of essential fish habitat from sound and potential pollution. Vessel traffic for all phases of the site assessment are addressed in this section.

HRG Survey Traffic

As detailed in Section 3.3.1.2, it is assumed that geophysical surveys for shallow hazards and archaeological resources would be conducted at the same time using the finer line spacing required for archaeological resource assessment (30 meters). Tie-lines would be run perpendicular to the track lines at a line spacing of 150 meters. This results in 767 miles of HRG surveys per OCS block. At 4.5 knots, it would take approximately 150 hours to survey one OCS block. Assuming eight hours of survey time per day during calm seas this would result in 19 vessel day-trips per lease block. Surveying a 300 meter-wide corridor along a potential cable route located outside of a WEA would result in about 5 miles or 1 hour of surveys per mile of cable. In order to survey the entire WEAs and potential cables, HRG surveys would have to be conducted by multiple vessels and/or over multiple years and potential cable routes. Based on these assumptions and one cable route per potential commercial wind facility, the proposed action would result in the following length or duration HRG surveys:

- New Jersey WEA: About 46,000 miles or 9,000 hours/1,125 vessel day-trips of HRG surveys.
- Delaware WEA: About 14,000 miles or 2,600 hours/325 vessel day-trips of HRG surveys.
- Maryland WEA: About 24,000 miles or 4,600 hours/575 vessel day-trips of HRG surveys.
- Virginia WEA: About 19,000 miles or 4,000 hours/500 vessel day-trips of HRG surveys.

Sub-Bottom Sampling Vessel Traffic

As described in the action scenario for sub-bottom sampling, it is estimated that there would need to be about 1,700 to 5,350 sub-bottom samples taken for the entire mid-Atlantic WEA. The amount of effort and vessel trips vary greatly by the type of technology used to retrieve the sample. The following details the type of vessels and collection time per sample:

- *Vibracores*: Would be likely be advanced from a single small vessel (~45 ft), and collect 4-7 samples per day.
- *CPT*: Depending on the size of the CPT, it could be advanced from medium vessel (~65 ft), a jack-up barge, a barge with a 4-point anchoring system, or a vessel with a dynamic positioning system. Each barge scenario would include a support vessel. This range of vessels could sample between 4-7 locations per day.
- *Geologic boring*: Would be advanced from a jack-up barge, a barge with a 4-point anchoring system, or a vessel with a dynamic positioning system. Each barge scenario would include a support vessel. Each deep geologic boring could take 1-2 days.

Based on the above information and the number of sub-bottom samples given in Section 3.3.4.1, the following range of vessel trips for each mid-Atlantic WEA was derived for all sub-bottom sampling. It should be noted that these ranges vary greatly due to the different technologies and vessels that could be used. Additionally, once some of the necessary equipment is on site there would not be the need for transit vessel trips, other than those transporting crew. Furthermore, a day is defined as 8-10 hours on the work site.

- New Jersey: 92 – 2,050 vessel day trips.
- Delaware: 35 – 780 vessel day trips.
- Maryland: 61-1,385 vessel day trips.
- Virginia: 49-1,105 vessel day trips.

Meteorological Tower Construction and Operation Traffic

The proposed action scenario estimates a maximum of 10 meteorological towers to be constructed throughout all of the mid-Atlantic WEAs. During installation, a radius of about 457.2 m (1,500 ft) around each site would be needed for the movement and anchoring of support vessels. A maximum of 3 vessel trips to and from the onshore staging area would occur during each day during installation. Depending on the foundation type used installation would take 8 days to 10 weeks. Table 3 uses an average of 40 days per structure for a total of 120 vessel trips per structure.

Several shipping lanes and navigational channels exist within the vicinity of the mid-Atlantic WEAs, normally producing vessel traffic within the vicinity of the proposed action area. During construction activities, especially during pile driving activities, it is estimated that 4 to 6 stationary or slow moving vessels would be present in the general vicinity of the pile installation. Vessels delivering construction materials or crews to the site will also be present in the area between the mainland and the construction sites. The barges, tugs and vessels delivering construction materials generally will travel at speeds below 10 knots (18.5 km/h) and may range in size from 90 to 400 ft (27.4 to 122 m), while the vessels carrying construction crews will be traveling at a maximum speed of 21 knots (39 km/h) and will typically be 50 ft (15 m) in length. The tower sections would be raised using a separate barge mounted crane or heavy lifting helicopter.

After installation data would be monitored and processed remotely reliving the need of cables to shore. The structure and instrumentation would be accessed by boat for routine maintenance. Monthly vessel trips due to operation and maintenance over the 4 to 5 year life of the met tower are expected for a total of 48 to 60 round trips per installation. These vessel trips would not require any additional or expansion of onshore facilities. It is projected that crew boats 15.5 to 17.4 m (51 to 57 ft) in length with an 800 to 1,000 hp engines and 1,800 gallon fuel capacity would be used to service the structure. The use of helicopters to transport personnel or supplies during operation and maintenance is not anticipated.

Vessel usage during decommissioning will be similar to vessel usage during construction. Up to about 40 round trips by various vessels are expected during decommissioning of each meteorological tower. Similar to construction, this yields an average of 120 round trips for the decommissioning of each met towers.

Meteorological Buoy Deployment and Operation
The proposed action scenario estimates a maximum of 20 meteorological buoys to be deployed throughout all the mid-Atlantic WEAs. As described in Section 3.3.5.3, the installation of each buoy could utilize 1-3 vessel trips per deployment. The types of vessels involved in the deployment include barge/tug (for buoy and/or anchoring system), large work vessel (for towing and/or carrying the buoy), and an additional support vessel (for crew and other logistical needs).

Similar to meteorological towers, it is expected that maintenance for the buoy would be required on a monthly basis resulting in maximum of 20 round-trips per month. Once again it should be noted that it is unlikely that all 20 met buoys would be in service at the same time over the entire period. For met buoys, the decommissioning is expected to be the reverse of the deployment, with 1-3 vessel trips required to retrieve each buoy.

Table 3. Total number of estimated vessel trips per WEA

WEA	HRG Survey	Sub-bottom sample	Met tower install	Met buoy install	Met tower ops	Met buoy ops	Met tower decom	Met buoy decom
New Jersey	1,125	92-2,050	480	16	240	480	480	16
Delaware	325	35-780	0	1	0	1	0	1
Maryland	575	61-1,385	360	12	180	360	360	12
Virginia	500	49-1,105	360	12	180	360	360	12

3.5 Onshore Activity

Several mid-Atlantic ports would be used as a fabrication sites, staging areas and crew/cargo launch sites. Existing ports or industrial areas are expected to be used. Expansion of these existing facilities is not anticipated in support of construction, operation or decommissioning activities.

Several major ports exist near the wind energy areas that are suitable to support the fabrication and staging of met towers. These ports include the Port of New York and New Jersey, Atlantic City, and industrial ports accessible via the Delaware Bay and Delaware River in New Jersey, Delaware, and Pennsylvania (Atlantic Renewable Energy Corporation and AWS Scientific, Inc., 2004). Hampton Roads marine terminals and shipyards would be likely ports for staging projects off of Virginia's coast.

For the construction of a met tower a platform would be constructed or fabricated onshore at a facility called a platform fabrication yard. Production operations at fabrication yards would include cutting, welding, and assembling of steel components. The yards occupy large areas with equipment including lifts and cranes, welding equipment, rolling mills, and sandblasting machinery. The location of these fabrication yards is directly tied to the availability of a large enough channel that will allow the towing of these bulky and long structures. The average bulkhead depth needed for water access to fabrication yards is 4.6 to 6.1 m (15 to 20 ft). A fabricator must also consider other physical limitations such as the ability to clear bridges and navigate tight corners within channels. Thus, platform fabrication yards must be located at deep-draft seaports or along the wider and deeper of the inland channels.

The met tower would be manufactured at a commercial facility in sections, and then shipped by truck, rail, or sea to the onshore staging area. The met tower would be partially assembled and loaded onto a barge for transport to the installation site. Final assembly of the tower would be completed offshore.

3.6 Decommissioning

Within a period of one year after cancellation, expiration, relinquishment or other termination of the lease, the lessee shall remove all devices, works and structures from the leased area and restore the leased area to its original condition before issuance of the lease. The current term for an offshore renewable energy lease is around 25 years in addition to the 5 years to complete site assessment activities. Failure to complete site assessment activities in the first 5 years of the lease, could result in revocation of the lease.

Decommissioning activities for a met tower would begin with the removal of all meteorological instrumentation from the tower. A derrick barge would be transport to the offshore site and anchored adjacent to the structure. The mast would be removed from the deck and loading onto the transport barge. The deck would be cut from the foundation structure and loaded on the transport barge. It is estimated that the entire removal process for a met tower would take one week or less.

Decommissioning activities for a met buoy would begin with the removal of the buoy from the anchoring system. The buoy would then be towed or transported to shore or redeployed under a separate assessment activity. The anchoring system (chain and weights) would be retrieved in the reverse manner it was deployed. In the case of a large clump weight anchor there is the possibility that the weight will remain in place on the seafloor in accordance with an artificial reef program or similar disposal as detailed in Section 4.6.4. It is estimated that the decommissioning of a met buoy will take 1-3 vessel trips over 1-3 days.

3.6.1 Cutting and Removing Piles

The project developer would sever bottom-founded structures and their related components at least 4.6 m (15 ft) below the mudline to ensure that nothing would be exposed that could interfere with future lessees and other activities in the area. BOEMRE prepared a programmatic EA, *Structure-Removal Operations on the Gulf of Mexico Outer Continental Shelf* (MMS 2005), to evaluate the full range of potential environmental impacts of structure-removal activities in detail the various technologies that could be used.

The EA on structure-removal, which is incorporated by reference, discusses in detail the both explosive and nonexplosive severing methods. BOEMRE assumes non-explosive severing methods can be used to decommission the proposed met towers. The applicants would be required to submit a decommissioning methodology in the SAP.

Common nonexplosive severing tools that may be used consist of abrasive cutters (e.g., sand cutters and abrasive water jets), mechanical (carbide) cutters, diver cutting (e.g., underwater arc cutters and the oxyacetylene/oxyhydrogen torches), and diamond wire cutters. Of these the most likely would be an internal cutting tool, such as a high pressure water jet-cutting tool. In order to cut a pile internally, the sand that had been forced into the hollow pile during installation would be removed by hydraulic dredging/pumping, and stored on a barge. Once cut, the steel pile would then be lifted on to a barge, and transported to shore. Following the removal of the cut pile and the adjacent scour control system, the sediments would be returned to the excavated pile site using a vacuum pump and diver assisted hoses. No excavation around the outside of the monopole or piles prior to the cutting is anticipated. Cutting and removing piles would take anywhere from several hours to one day per pile. After the foundation is severed, it would be lifted on the transport barge and towed to the decommissioning site.

Issuance of a lease would not constitute the approval of explosive severing methods. If a lessee intends to use explosive severing methods then a detailed decommissioning plan must be submitted to BOEMRE for approval, in addition to any other requirements of the lease. Proposed use of explosives would likley require supplemental NEPA analysis and re-initiation of ESA Section 7 consultations.

3.6.2 Removal of Scour Control System

During decommissioning of a met tower, the scour control system would also be removed. Scour mats would be removed by divers or ROV, and a support vessel in a similar manner to installation. Removal is expected to result in greater amounts of suspended sediments than levels associated with the original installation of the mats. It is anticipated that the sandy nature of the bottom material over most of the proposed lease blocks would result in rapid settling of the suspended sediment material. If rock armoring is used, armor stones would be removed using a clamshell dredge or similar equipment and placed on a barge. It is estimated that the removal of the scour control system would take a half day per pile, therefore depending on the foundation structure removal of the scour system would take a total of 0.5 to 2 days to remove the scour control system around a meteorological tower.

3.6.3 Disposal

All materials would be removed by barge and transported to shore. The steel would be recycled and remaining materials would be disposed of in existing landfills in accordance with applicable regulations.

3.6.4 Artificial Reefs

The use of obsolete materials as artificial reefs have been used along the coastline of the U.S. to provide valuable habitat for numerous species of fish in areas devoid of natural hard bottom. The BOEMRE supports and encourages the reuse of obsolete offshore petroleum structures as artificial reefs. The proposed structures may also have the potential to serve as artificial reefs. The structure must not pose an unreasonable impediment to future development. The reuse Rigs-to-Reefs plan must comply with the artificial reef permitting requirements of the U.S. Army Corps of Engineers and the criteria in the National Artificial Reef Plan. States in the northeast and mid-Atlantic regions have artificial reef programs. The State agency responsible for managing marine fisheries resources must accept liability for the structure before the BOEMRE will release the Federal lessee from obligations in the lease instrument.

4.0 Effects of the Proposed Action on EFH and Managed Species

The proposed action has 5 primary activities that could impact essential fish habitat and managed species. These activities are: (1) HRG surveys, (2) sub-bottom reconnaissance, (3) deployment of a met buoy or construction of a met tower, (4) operation of met tower and met buoys, and (5) other activities. The potential effects to EFH and managed species from these activities can be grouped into the following broad categories: (1) acoustic effects, (2) benthic habitat effects, and (3) other effects.

4.1 Description of the Environment

Section 4.2 of the Programmatic EIS (MMS 2007b) gives a thorough description of the geology, biology, meteorology, and acoustics of the entire BOEMRE Atlantic planning area.

The mid-Atlantic WEAs are located in the mid-Atlantic Bight (MAB) of the Northeast Continental Shelf Large Marine Ecosystem. The following MAB characterization and table are adopted from *Characterization of the Fishing Practices and Marine Benthic Ecosystems of the Northeast U.S. Shelf* (NOAA Technical Memo NMFS-NE-181, 2004 cited as Johnson 2002). The Nature Conservancy has also compiled several decades of NMFS benthic grab sample data into an informative geodatabase as part of their Northwest Atlantic Marine Ecoregional Assessment (NAM ERA). This data is presented in Appendix 1 and the associated legend. The MAB includes the shelf and slope waters from Georges Bank south to Cape Hatteras, and east to the Gulf Stream. Like the rest of the continental shelf, the topography of the MAB was shaped largely by sea-level fluctuations caused by past ice ages. The shelf's basic morphology and sediments derive from the retreat of the last ice sheet, and the subsequent rise in sea level. Since that time, currents and waves have modified this basic structure.

Physical Features

The shelf slopes gently from shore out to between 100 and 200 km offshore where it transforms to the slope (100-200 m of water depth) at the shelf break. In both the Mid-Atlantic and on Georges Bank to the northeast, numerous canyons incise the slope, and some cut up onto the shelf itself. The primary morphological features of the shelf include shelf valleys and channels, shoal massifs, scarps, and sand ridges and swales. The sediment type covering most of the shelf in the MAB is sand, with some relatively small, localized areas of sand-shell and sand-gravel. On the slope, silty sand, silt,and clay predominate.

Sand ridges are more modern in origin than the shelf's glaciated morphology. Their formation is not well understood; however, they appear to develop from the sediments that erode from the shore face. They maintain their shape, so it is assumed that they are in equilibrium with modern current and storm regimes. They are usually grouped, with heights of about 10 m, lengths of 10-50 km, and spacing of about 2 km. Ridges are usually oriented at a slight angle towards shore, running in length from northeast to southwest. The seaward face usually has the steepest slope. Sand ridges are often covered with smaller similar forms such as sand waves, megaripples, and ripples. Swales occur between sand ridges. Since ridges are higher than the adjacent swales, they are exposed to more energy from water currents, and experience more sediment mobility than swales. Ridges tend to contain less fine sand, silt, and clay, while relatively sheltered swales contain more of the finer particles. Swales have greater benthic macrofaunal density, species richness, and biomass due, in part, to the increased abundance of detrital food and the physically less rigorous conditions. Sand waves are usually found in patches of 5-10 with heights of about 2 m, lengths of about 50-100 m, and spacing of about 1-2 km. Sand waves are primarily found on the inner shelf, and often observed on sides of sand ridges. Sand waves may remain intact over several seasons. Megaripples occur on sand waves or separately on the inner or central shelf. During the winter storm season, these megaripples may cover as much as 15% of the inner shelf. They tend to form in large patches and usually have lengths of about 3-5 m with heights of about 0.5-1 m. Megaripples tend to survive for less than a season. They can form during a storm and reshape the upper 50-100 cm of the sediments within a few hours. Ripples are also found everywhere on the shelf, and appear or disappear within hours or days, depending upon storms and currents. Ripples usually have lengths of about 1-150 cm and heights of a few centimeters.

Natural and artificial reefs are another important feature mid-Atlantic benthic habitat. Natural reefs in the mid-Atlantic consist largely of exposed rock outcrops or random boulders left by retreating glaciers or rafted from icebergs, or erosion of sediment-covered rock or deltaic deposits of rock, cobble, and gravel along former river channels across a retreating shoreline since the last glacial period. There are reports of submerged ridges of aragonitic sandstones (Steimle and Zetlin 2000). Steimle and Zetlin (2000) also report occurrences of northern star coral (*Astrangia poculata*) and molluscan shell deposits that provide biogenic benthic structure to the environment.

Artificial reefs are localized areas of hard structure have been formed by shipwrecks, lost cargoes, disposed solid materials, shoreline jetties and groins, submerged pipelines, cables, and other materials (Steimle and Zetlin 2000). Steimle and Zetlin (2000) cite reports by commercial fishermen of cobbles and loose rock patches associated with gravelly areas in coastal areas. These areas could represent river deltaic deposits during periods of lower sea levels; but some could be ballast stones from old wooden shipwrecks. Off coastal Delaware and south these rocky patch are also associated with “live bottom,” i.e. the rocks are colonized by sea whips, stone coral, and other biogenic structural enhancers.

While some of reef structure may have been deposited specifically for use as fish habitat, most have an alternative primary purpose; however, they have all become an integral part of the coastal and shelf ecosystem. It is expected that the increase in these materials has had an effect on living marine resources and fisheries, but these effects are not well known. In general, reefs are important for attachment sites, shelter, and food for many species (Johnson 2002).

<u>Fishing Grounds</u>

The National Marine Fisheries Service (Freeman and Walford 1974) and the New Jersey Department of Environmental Protection (Long and Figley 1981) have identified fishing grounds off the Atlantic Coast, including grounds within the mid-Atlantic WEAs. The fact that fishing occurs in the mid-Atlantic WEAs is borne out in Figures 11-12 which show commercial and recreational fishing effort from NMFS fishing vessel trip reports for the 4-year period 2004-2008.

Biological Features

As reported by Johnson (2002) the Mid-Atlantic shelf was divided by Boesch (1979) into seven bathymetric/morphologic subdivisions based on faunal assemblages (Table 4). Sediments in the region studied (Hudson Shelf Valley south to Chesapeake Bay) were dominated by sand with little finer materials. Ridges and swales are important morphological features in this area. Sediments are coarser on the ridges, and the swales have greater benthic macrofaunal density, species richness, and biomass. Faunal species composition differed between these features, and Boesch (1979) incorporated this variation in his subdivisions (Table 4). Much overlap of species distributions was found between depth zones, so the faunal assemblages represented more of a continuum than distinct zones.

Table 4. Mid-Atlantic habitat types (Johnson 2002)			
Habitat Type [after Boesch (1979)	**Depth (m)**	**Characterization (Pratt (1973) faunal zone)**	**Characteristic Benthic Macrofauna**
Inner Shelf	0-30	Course sands with finer sands off MD and VA (sand zone)	Polychaetes: *Polygordius, Goniadella,*and *Spiophanes*
Central Shelf	30-50	(sand zone)	Polychaetes: *Goniadella,*and *Spiophanes* Amphipods: *Pseudunciola*
Central and inner shelf swales	0-50	Occurs in swales between sand ridges (sand zone)	Polychaetes: *Polygordius, Lumbrineris,*and *Spiophanes*
Outer shelf	50-100	(silty-sand zone)	Polychaetes: *Spiophanes* Amphipods: *Ampelisca vadrum* and *Erichthonius*
Outer shelf swales	50-100	Occurs in swales between sand ridges (silty-sand zone)	Amphipods: *Ampelisca agassizi, Unciola,* and *Erichthonius*
Shelf break	100-200	(silt-clay zone)	NA
Continental slope	>200	(none)	NA

4.2 Federally-Managed Marine Fish

Table 5 characterizes the major demersal finfish assemblages of the mid-Atlantic bight, most of which are federally-managed in commercial and recreational fisheries. The proceeding section, Section 4.3, lists the full range of species managed under the Magnuson-Stevens Act that may be present in the WEAs for at least one life stage. The species list also includes several species of concern- due to diminished population levels, that may be found in the WEAs. The complete list of fish species of concern includes 3 shark species; the dusky shark, the porbeagle shark, and the sand tiger shark; two herring; the alewife, blueback herring; and the rainbow smelt (NMFS 2010b). An additional species of concern is the American eel, for which USFWS is the lead Federal agency responsible for conservation.

The dusky shark is found off New Jersey and Delaware, occurring from the surf zone to well offshore, and from surface waters to depths of 39.6 m (1300 ft). The dusky shark is not commonly found in estuaries due to a lack of tolerance for low salinities. The species migrates northward in summer and southward in fall. Appendix 2 shows dusky shark EFH in relation to the mid-Atlantic WEAs. Sand tiger sharks are found along the East Coast, including New Jersey and Delaware. They are generally a coastal species, usually found from the surf zone to depths of about 22.9 m (75 ft). They are, however, sometimes found at depths of 182.9 m (600 ft). Porbeagle sharks are pelagic and rarely enter shallow coastal waters. They are distributed in the water column from the surface down to depths of up to 1000 feet. In the U.S. Northwest Atlantic the species range from Maine to New Jersey with the primary concentration the Gulf of Maine and Georges Bank. However, essential fish habitat for porbeagle has been identified on the continental shelf off Virginia and North Carolina.

Herrings and smelts are generally found throughout the mid-Atlantic in nearshore waters, coastal bays and estuaries up to spawning grounds in upstream riverine habitats. Their decline has generally been attributed to loss of upstream habitat due to man-made impediments (i.e., dams) and fishing pressure.

American eel (*Anguilla rostrata*) are found in fresh, brackish, and coastal waters from the southern tip of Greenland to northeastern South America. American eels begin their lives as eggs hatching in the Sargasso Sea. They take years to reach freshwater streams where they mature, and then they return to their Sargasso Sea birth waters to spawn and die. They are the only species of freshwater eels in the Western Hemisphere. Threats to American eel include habitat loss, including riverine impediments, pollution and nearshore habitat destruction; and fishing pressure (Greene et al 2009).

Table 5. Major recurrent demersal finfish assemblages of the mid-Atlantic bight during spring and fall (as determined by Colvocoresses and Musick (1984)).

Season	**Species Assesmblage**				
	Boreal	**Warm Temperate**	**Inner Shelf**	**Outer Shelf**	**Slope**
Spring	Atlantic cod Little skate Sea raven Monkfish Winter flounder Longhorn sculpin Ocean pout Silver hake (Whiting) Red hake White hake Spiny dogfish	Black sea bass Summer flounder Butterfish Scup Spotted hake Northern searobin	Windowpane flounder	Fourspot flounder	Shortnose greeneye Offshore hake Blackbelly rosefish White hake
Fall	White hake Silver hake (whiting) Red hake Monkfish Longhorn	Black sea bass Summer flounder Butterfish Scup	Windowpane flounder	Fourspot flounder Cusk eel Gulf stream flounder	Shortnose greeneye Offshore hake Blackbelly rosefish White hake

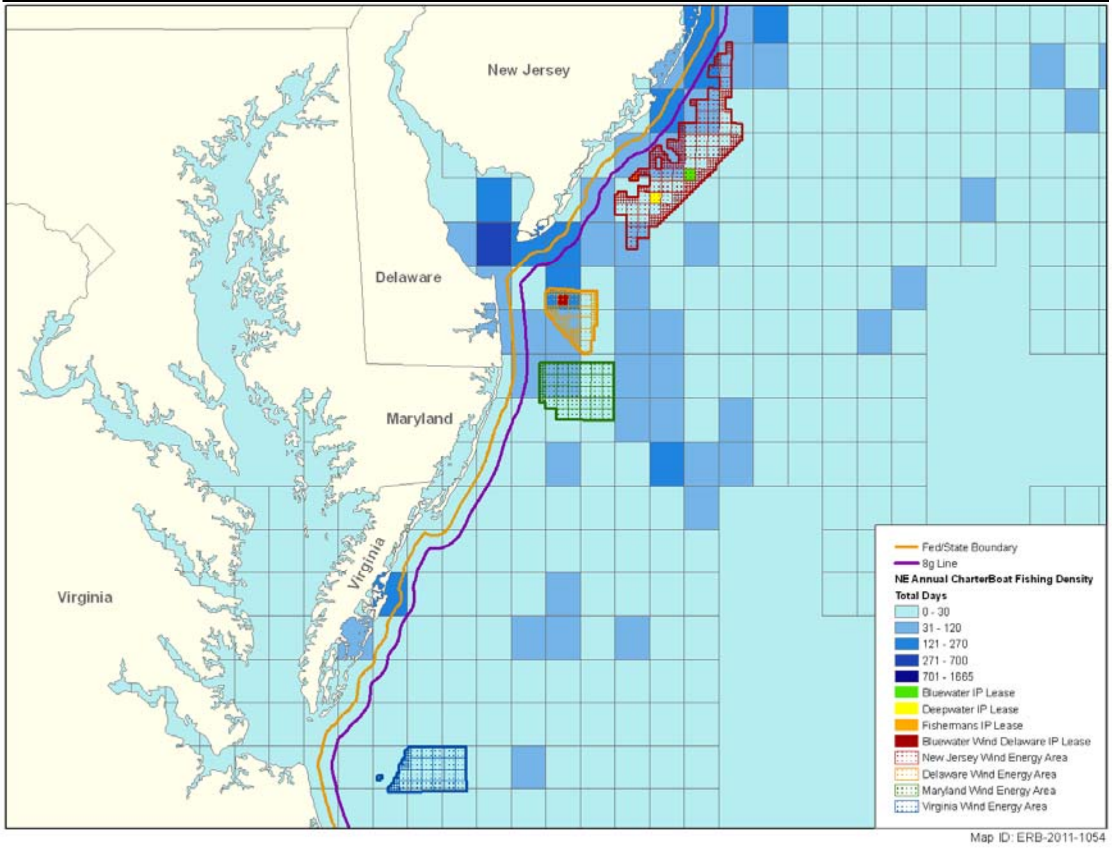
	sculpin Winter flounder Yellowtail flounder Witch flounder Little skate Spiny dogfish	Spotted hake Northern searobin Smooth dogfish			Witch flounder

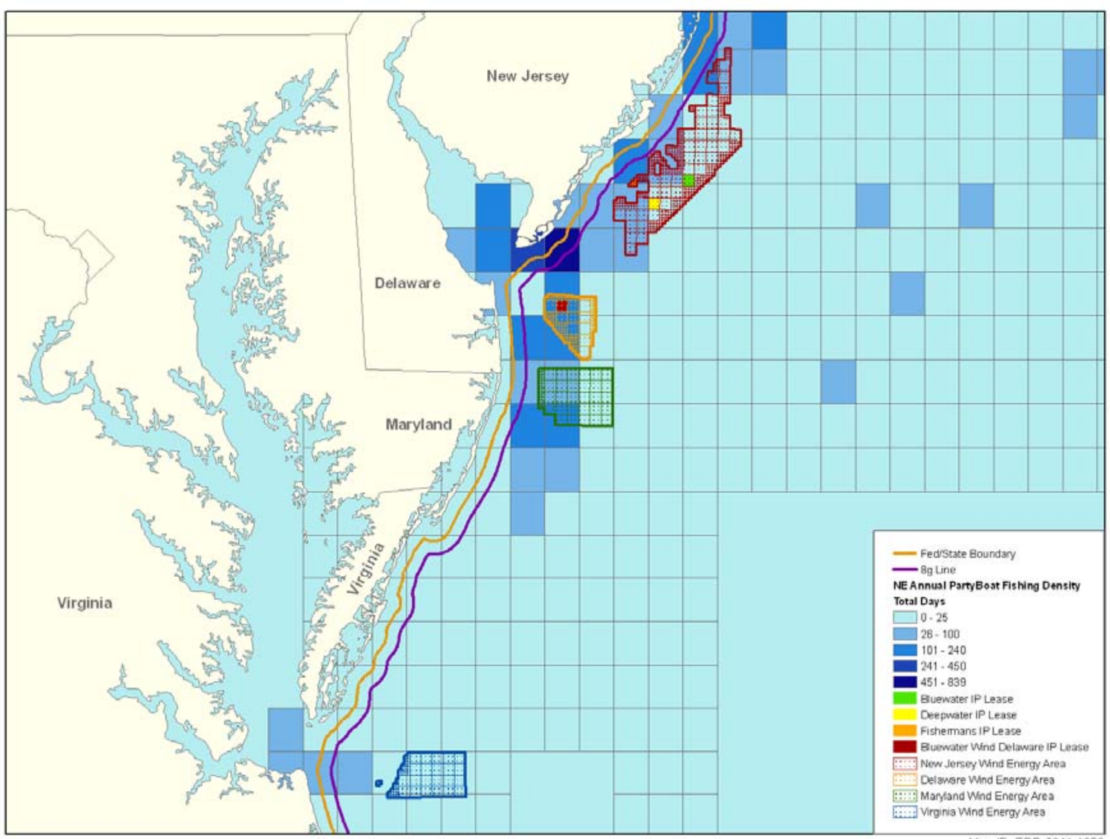
The area encompassed by the mid-Atlantic WEAs is used actively for both commercial and recreational fishing. The following section discusses these activities in the context of what may be impacted by the proposed action. An overview of commercial and recreational fishing for the entire Atlantic region are discussed in Chapters 4.2.23.1 and 4.2.23.2 of the Programmatic EIS, respectively.

Recreational Fishing

The mid-Atlantic region boasts an active recreational fishing sector in offshore Federal waters. Between 2008 and 2010 New Jersey, Delaware, Maryland, and Virginia these states averaged 550,000, 24,000, 67,500, and 54,250 recreational fishing trips in Federal waters respectively (NMFS Office of Science and Technology Personal Communication 2011). The top recreational species by weight in the mid-Atlantic for the same time period were bluefish, black sea bass, Atlantic striped bass, and dolphin (NMFS Office of Science and Technology Personal Communication 2011). Figure 11 below shows recreational fishing via federally-permitted party and charter vessels in each of the mid-Atlantic WEAs. The data in these figures is compiled from NMFS fishing vessel trip report data for the 4-year period 2004-2008.

Figure 11. Recreational fishing effort in mid-Atlantic WEAs 2004-2008 (NMFS)





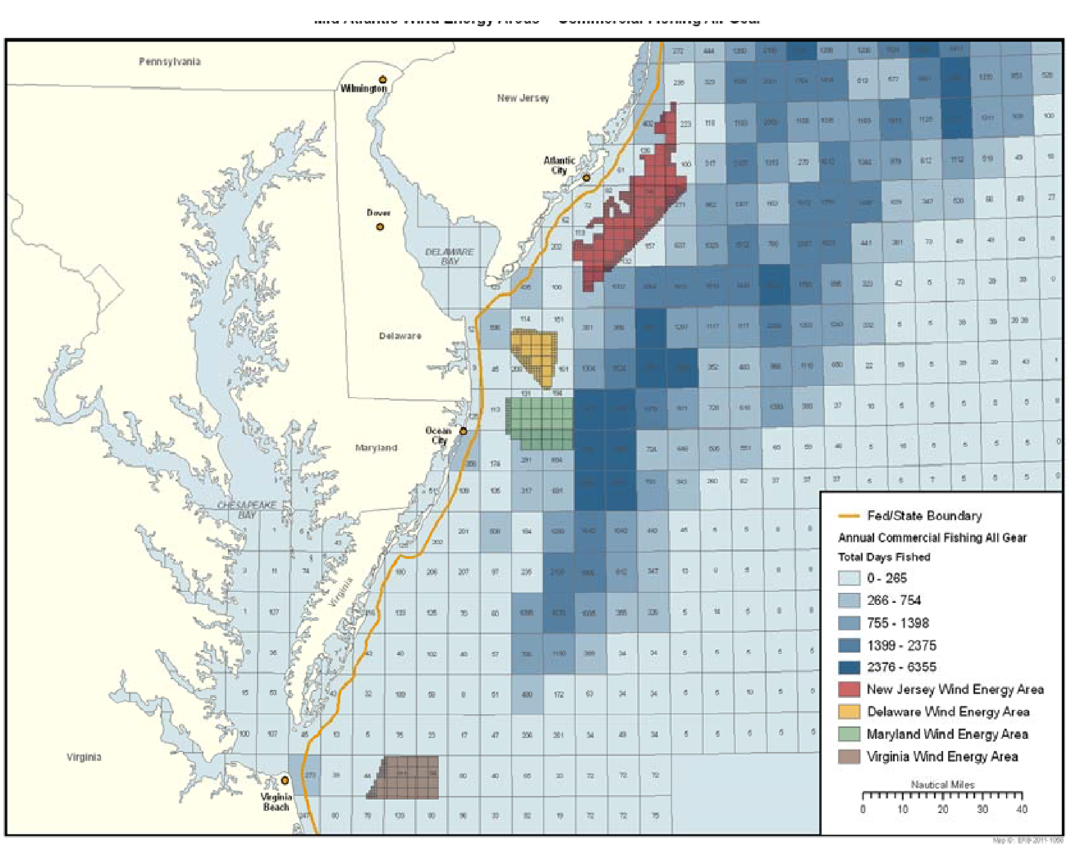
Commercial Fishing

The most important species by dollar value amongst the states adjacent to the mid-Atlantic WEAs are sea scallops, surf clams, ocean quahogs, menhaden, striped bass, and blue crab (NMFS Office of Science and Technology personal communication 2011). The total landed commercial fishery weight and value for each state in 2009 is presented in Table 6. However, it should be noted that that state of landing may not reflect the area from which the fishery is prosecuted. For instance, striped bass fishing is prohibited beyond 3 miles from shore, blue crab is primarily an estuarine species, and ocean quahogs are generally harvested in deeper and/or colder waters than those directly adjacent to New Jersey where they are landed. Figure 12 below shows commercial fishing via federally-permitted fishing vessels in each of the mid-Atlantic WEAs. The data in these figures is compiled from NMFS fishing vessel trip report data for the 4-year period 2004-2008.

Table 6. Total commercial fishery landed weight and value in 2009.

Year	State	Metric Tons	Pounds	$
2009	Delaware	2,272.60	5,010,175	7,535,780
2009	New Jersey	73,300.80	161,598,836	149,032,131
2009	Maryland	30,986.60	68,312,955	76,057,117
2009	Virginia	193,346.80	426,252,313	152,729,830
Grand Total		299,906.80	661,174,279.00	385,354,858.00

Figure 12. Commercial fishing effort in mid-Atlantic WEAs 2004-2008 (NMFS)



4.3 Essential Fish Habitat and Habitat Areas of Particular Concern

The following list of species managed under the provisions of the Magnuson-Stevens Act have one or more EFH life stage within the mid-Atlantic WEAs. The species are grouped according the appropriate management authority. The mid-Atlantic WEAs do not overlap with any habitat areas of particular concern (HAPC). However, sandbar shark HAPC is located inshore of New Jersey, Delaware, and Virginia WEAs which may be transited by vessels and/or surveyed for site characterization of possible cable routes to shore.

New England Fishery Management Plan Species

Atlantic herring
Atlantic sea scallops
Barndoor skate
Clearnose skate
Haddock
Little skate
Monkfish
Ocean pout
Offshore hake
Red hake
Rosette skate
Silver hake
Smooth skate
Thorny skate
Witch flounder
Yellowtail flounder
Winter flounder
Window Pane flounder

Mid-Atlantic Fishery Management Plan Species

Atlantic mackerel
Black sea bass
Bluefish
Butterfish
Surfclam
Monkfish
Ocean quahog
Scup
Spiny dogfish
Summer flounder
Illex squid
Loligo squid

South Atlantic Fishery Management Plan Species

Cobia
King mackerel
Spanish mackerel

Highly Migratory Species Fishery Management Plan Species

Albacore tuna
Atlantic angel shark
Atlantic bigeye tuna
Atlantic bluefin tuna
Atlantic sharpnose
Atlantic skipjack
Atlantic swordfish
Atlantic yellowfin tuna
Basking shark
Blue marlin
Blue shark
Dusky shark
Longfin mako
Porbeagle
Sand tiger shark
Sandbar shark
Scalloped hammerhead
Shortfin mako
Silky shark
Thresher shark
Tiger shark
White marlin
White shark
Bigeye Sand Tiger Shark
Bigeye Sixgill Shark
Caribbean Sharpnose Shark
Galapagos Shark
Narrowtooth Shark
Sevengill Shark
Sixgill Shark
Smooth Hammerhead Shark
Smalltail Shark
Smooth Dogfish
Longbill Spearfish
Blacktip Shark

4.4 Acoustic Effects

This Section on acoustic effects looks at what is known about acoustic sensitivity in marine fish and the sound that could be produced as a result of site assessment activity in the mid-Atlantic WEAs. This Section is derived in large part from previous consultations and biological opinions issued by NMFS to BOEMRE for Atlantic wind energy projects. Marine organisms rely on sound to communicate with conspecifics and derive information about their environment. There is growing concern about the effect of increasing ocean noise levels due to anthropogenic sources on marine organisms. Effects of noise exposure on marine organisms can be characterized by the following range of physical and behavioral responses (Richardson et al. 1995):

1. Behavioral reactions – Range from brief startle responses, to changes or interruptions in feeding, diving, or respiratory patterns, to cessation of vocalizations, to temporary or permanent displacement from habitat.
2. Masking – Reduction in ability to detect communication or other relevant sound signals due to elevated levels of background noise.
3. Temporary threshold shift (TTS) – Temporary, fully recoverable reduction in hearing sensitivity caused by exposure to sound.
4. Permanent threshold shift (PTS) – Permanent, irreversible reduction in hearing sensitivity due to damage or injury to ear structures caused by prolonged exposure to sound or temporary exposure to very intense sound.
5. Non-auditory physiological effects – Effects of sound exposure on tissues in non-auditory systems either through direct exposure or as a consequence of changes in behavior, e.g., resonance of respiratory cavities or growth of gas bubbles in body fluids.

The auditory thresholds of marine fish that could occur in the mid-Atlantic WEAs is not well studied. The following description provides a range of auditory systems and perceived sound in fish. The octavolateralis system of fish is used to sense sound, vibrations, and other forms of water displacement in the environment, as well as to detect angular acceleration and changes in the fish's position relative to gravity (Popper et al. 2003). The major components of the octavolateralis system are the inner ear and the lateral line. The basic functional unit in the octavolateralis system is the sensory hair cell, a highly specialized cell that is stimulated by mechanical energy (e.g., sound, motion) and converts that energy to an electrical signal that is compatible with the nervous system of the animal. The sensory cell found in the octavolateralis system of fish and elasmobranchs is the same sensory cell found in the ears of terrestrial vertebrates, including humans (Coffin et al. 2004). Both components of the octavolateralis system, the ear and the lateral line, send their signals to the brain in separate neural pathways. However, at some levels the two systems interact to enable the fish to detect and analyze a wide range of biologically relevant signals (Coombs et al. 1989).

The ear and the lateral line overlap in the frequency range to which they respond. The lateral line appears to be most responsive to signals ranging from below one Hz to between 150 and 200 Hz (Coombs et al. 1992), while the ear responds to frequencies from about 20 Hz to several thousand Hz in some species (Popper and Fay 1993; Popper et al. 2003). The specific frequency response characteristics of the ear and lateral line varies among different species and is probably related, at least in part, to the life styles of the particular species.

Hearing is better understood for bony fish than for other fish, such as cartilaginous fish like sharks and jawless fish (class Agnatha) (Popper and Fay 1993; Ladich and Popper 2004). Bony fish with specializations that enhance their hearing sensitivity have been referred to as hearing "specialists," whereas those that do not posses such capabilities are called "nonspecialists" (or "generalists"). Popper and Fay (1993) suggest that in the hearing specialists, one or more of the otolith organs may respond to sound pressure as well as to acoustic particle motion. The response to sound pressure is thought to be mediated by mechanical coupling between the swim bladder (the gas-filled chamber in the abdominal cavity that enables a fish to maintain neutral buoyancy) or other gas bubbles and the inner ear. With this coupling, the motion of the gas-filled structure, as it expands and contracts in a pressure field, is brought to bear on the ear. In nonspecialists, however, the lack of a swim bladder, or its lack of coupling to the ear, probably results in the signal from the swim bladder attenuating before it gets to the ear. As a consequence, these fish detect little or none of the pressure component of the sound (Popper and Fay 1993).

The vast majority of fish studied to date appear to be non-specialists (Schellart and Popper 1992; Popper et al. 2003), and only a few species known to be hearing specialists inhabit the marine environment (although lack of knowledge of specialists in the marine environment may be due more to lack of data on many marine species, rather than on the lack of there being specialists in this environment). Some of the better known marine hearing specialists are found among the Beryciformes (i.e., soldierfish and especially Holocentridae, which includes the squirrelfish) (Coombs and Popper 1979), and Clupeiformes (i.e., herring and shad) (Mann et al. 1998, 2001). Even though there are hearing specialists in each of these taxonomic groups, most of these groups also contain numerous species that are nonspecialists. In the family Holocentridae, for example, there is a genus of hearing specialists, *Myripristis*, and a genus of nonspecialists, *Adioryx* (Coombs and Popper 1979).

Audiograms (measures of hearing sensitivity) have been determined for over 50 fish (mostly fresh water) and four elasmobranch species (Fay 1988; Casper et al. 2003). An audiogram plots auditory thresholds (minimum detectable levels) at different frequencies and depicts the hearing sensitivity of the species. It is difficult to interpret audiograms because it is not known whether sound pressure or particle motion is the appropriate stimulus and whether background noise determines threshold. The general pattern that is emerging indicates that the hearing specialists detect sound pressure with greater sensitivity over a wider bandwidth (to 3 kHz or above) than the nonspecialists. Also, the limited behavioral data available suggest that frequency and intensity discrimination performance may not be as acute in nonspecialists (Fay 1988).

The specialists whose best hearing is below about 1,000 Hz appear well adapted to this particular range of frequencies, possibly because of the characteristics of the signals they produce and use for communication, or the dominant frequencies that are found in the general underwater acoustic environment to which fish listen (Schellart and Popper 1992; Popper and Fay 1997, 1999; Popper et al. 2003). The region of best hearing in the majority of fish for which there are data available is from 100 to 200 Hz up to 800 Hz. Most species, however, are able to detect sounds to below 100 Hz, and often there is good detection in the LF range of sounds. It is likely that as data are accumulated for additional species, investigators will find that more species are able to detect low frequency sounds fairly well.

As for sound production in fish, Myrberg (1980) states that members of more than 50 fish families produce some kind of sound using special muscles or other structures that have evolved for this role, or by grinding teeth, rasping spines and fin rays, burping, expelling gas, or gulping air. Sounds are often produced by fish when they are alarmed or presented with noxious stimuli (Myrberg 1981; Zelick et al. 1999). Some of these sounds may involve the use of the swim bladder as an underwater resonator. Sounds produced by vibrating the swim bladder may be at a higher frequency (400 Hz) than the sounds produced by moving body parts against one another. The swim bladder drumming muscles are correspondingly specialized for rapid contractions (Zelick et al. 1999).

Myrberg (1981) has identified various categories of acoustic communication that are used by fishes. These are startle or warning sounds that may help protect individuals and groups from predation; courting sounds used as part of the usual mating behaviors including advertisement; swimming sounds used in schooling and aggregation; aggressive sounds used when competing for mates; sounds used in other aggressive interactions (e.g., in territorial defense); sounds used by interceptor species to avoid predation or to locate prey; and sounds overheard and used to competitive advantage by competitors. Sounds are known to be used in reproductive behavior by a number of fish species, and the current data lead to the suggestion that males are the most active producers. Sound activity often accompanies aggressive behavior in fish, usually peaking during the reproductive season. Those benthic fish species that are territorial in nature throughout the year often produce sounds regardless of season, particularly during periods of high-level aggression (Myrberg 1981). In addition to the behaviors classified by Myrberg (1981) as communication, it is also likely that hearing is used to help form a general image of the auditory scene that may include both other fishes and abiotic sound sources and scatterers.

4.4.2 High Resolution Geological Survey Acoustic Effects

High resolution geological surveys (HRG Surveys) may be employed to characterize ocean-bottom topography and subsurface geology. The HRG survey would also investigate potential benthic biological communities (or habitats) and archaeological resources. Specifically, high resolution site surveys would be used under the proposed action to characterize the potential site of the meteorological tower and possible placement of wind turbines in the future. As previously stated in Section 3.3.1, HRG surveys and sub-bottom profiling tools for wind turbine siting use less intense sound sources than air guns that are used for deeply penetrating 2D and 3D exploratory seismic surveys used in oil and gas exploration. Thus wind turbine siting HRG surveys result in much shallow penetration of the seafloor and less energy (sound) introduced into the environment.

Section 3.3 details a proposed action scenario for HRG surveys. The survey would likely consist of a vessel towing an acoustic source (boomer and/or chirper) about 25m behind the ship and a 600-m streamer cable with a tail buoy. Surveys would be conducted during daylight hours over a lengthy (several years) but unspecified period of time as developers respond to requests to develop WEAs and secure financing to conduct surveys. The total mid-Atlantic WEA survey area includes the entire project footprint where wind turbines could be installed and 115 kV submarine cable routes. Total HRG survey time is conservatively estimated at 17,900 hours for all the mid-Atlantic WEAs (915 square nautical miles). The complete state-by-state breakdown of HRG surveys in in Section 3.3.1.

The sound levels at the source (i.e., the boomer, chirper survey vessel) will depend on the type of equipment used for the survey. An example of the type of equipment to be used is in Table 1. Acoustic energy generated by these survey instruments is directed downward at the seafloor and not directed horizontally. The surveys would likely use the full daylight hours available to them, approximately 10 hours per day, however, the time that any particular area will experience elevated sound levels will be significantly shorter.

The subbottom profilers generate sound within the hearing thresholds of most fish that may occur in the action area. As noted in Table 1, the chirp has a sound source level of 201 dB re 1µPa rms with a typical pulse length of 32 milliseconds and a pulse repetition rate of 4 per second. A typical boomer has a sound source level of around 205 dB re 1µPa rms with a pulse duration of 150-200 microseconds and a pulse repetition rate of 3 per second.

An acoustic evaluation conducted by Cape Wind Associates for their project on Horseshoe Shoal off of Massachusetts indicated that HRG survey noise dissipated to 180 dB at 16 meters from the source for the chirper and 27 meters for the boomer. Underwater sound levels dissipated to 160 dB at 227 meters from the source for the chirper, and at 386 meters from the source for the boomer. However, it should be noted that this information serves as a guide and that different equipment may produce different results in different sub-marine environments. For general discussion purposes these zones of ensonification for acoustic harassment have been rounded up to 30m and 400m for the boomer at 160dB and 180dB respectively.

The impact of HRG survey noise on marine fish that could occur in the mid-Atlantic WEAs is not well understood. Generally, noise generated by HRG surveys may have physical and/or behavioral effects on fish. In reviewing the results of their study and that of the few previous studies, Hastings et al. (1996) suggested that sounds 90 to 140 dB above a fish's hearing threshold may potentially injure the inner ear of a fish. This suggestion was supported in the findings of Enger (1981) in which injury occurred only when the stimulus was 100 to 110 dB above threshold at 200 to 250 Hz for the cod. Hastings et al. (1996) derived the values of 90 to 140 dB above threshold by examining the degree of masking and how similar the masking signal and test signal are. The data on other species are much less extensive. Chapman and Hawkins (1973) found that ambient noise at higher sea states in the ocean have masking effects in cod, haddock, and pollock. Thus, based on limited data, it appears that for fish masking may occur in the frequency region of the signal.

Effects on fish are generally expected to be limited to avoidance of the area around the HRG Survey activities and short-term changes in behavior. The region of best hearing in the majority of fish for which there are data available is from 100 to 200 Hz up to 800 Hz. Fish are highly mobile and may be expected to quickly leave an area when an HRG survey is initiated. While an HRG survey may disturb more than one individual, routine surveys are not expected to result in population-level effects. Individuals disturbed by a survey would likely return to normal behavioral patterns after the survey has ceased (or after the animal has left the survey area).

Fish are not expected to be exposed to sound pressure levels that could cause hearing damage. Side-scan sonar, which uses a low-energy, high-frequency signal, is not expected to affect fish, based on fish hearing data. Because of the limited immediate area of ensonification and duration of individual HRG surveys that may be conducted during site assessment, few fish may be expected in most cases to be present within the survey areas. Thus, potential population-level impacts on fish from HRG surveys are expected to be negligible.

4.4.3 Sub-bottom Reconnaissance Acoustic Effects

It is envisioned that the majority of sub-bottom sampling work will be accomplished via CPTs, and to a more limited extent vibracores, which does not require deep borehole drilling. However, some geologic conditions may prevent sufficient data being acquired from vibracores and CPTs and require obtaining a geologic profile via a borehole. Acoustic impacts from borehole drilling are expected to be below 120 dB. Previous estimates submitted to BOEMRE for geotechnical drilling have source sound levels not exceeding 145dB at a frequency of 120Hz (NMFS 2009). Previous submissions to BOEMRE also indicated that boring sound should attenuate to below 120 dB by the 150m isopleth.

4.4.4 Met Tower Pile-Driving Noise

The type and intensity of the sounds produced by pile driving depend on a variety including the type and size of the pile, the firmness of the substrate into which the pile is driven, the depth of the water, and the type and size of the impact hammer being used. Thus the actual sounds produced will vary project by project. Regardless, this Section will attempted to capture the range of acoustic impacts from pile driving and base the mitigation measures in Section 7.0 upon these conservative estimates.

Pile driving is expected to generate sound levels in excess of 200 dB and have a relatively broad band of 20 Hz to >20 kHz (Madsen et al. 2006; Thomsen et al. 2006). Sound attenuation modeling done during construction at Utgrunden Wind Park in the Baltic Sea in 2000 and adopted as the model for the Cape Wind Energy Project (Report 4.1.2-1 (Noise Report) of the FEIS) indicates that underwater noise levels may be greater than 160 dB re 1 uPa within approximately 3.4km of the pile being driven. At distances greater than 3.4km from the pile being driven, noise levels will have dissipated to below 160 dB re 1 uPa. It should be noted that these measurements are for a 1.7 MW turbine mounted upon a monopile of approximately 5m in diameter and not a meteorological tower. Generally, the larger the diameter of the monopole the greater the noise produced from pile driving (Nedwell 2007). Actual measured underwater sound levels during the construction of the Cape Wind met tower in 2003 were 145-167 dB at 500m with peak energy at around 500Hz.

Alternatively, modeling conducted by Bluewater Wind, LLC in for proposed met tower sites in New Jersey and Delaware under interim policy leases places the 160 dB isopleth at 7,230m for Delaware and 6,600m (NMFS 2010c). Generally, it is anticipated that actual pile driving time would last 3-8 hours per pile driven for sites in the mid-Atlantic WEAs. The information from Cape Wind Energy and Bluewater Wind represent a good range of the area of ensonification at the 180 dB and 160 dB levels. This is detailed in Table 6 below.

Table 7. Modeled areas of ensonification from pile driving.

Project (modeled)	Additional Info	180 dB re 1μPa (rms)	160 dB re 1μPa (rms)
Bluewater Wind (IP	3.05m diameter	760m	7,230m

Lease Delaware)	monopole; 900kJ hammer		
Bluewater Wind (IP Lease New Jersey)	3.05m diameter monopole; 900kJ hammer	1,000m	6,600m
Cape Wind Energy (Lease Nantucket Sound)	5.05m monopole; 1,200kJ hammer	500m	3,400m
BOEMRE Mandatory Exclusion Zones	**See Section 7.0 for details**	**1,000m**	**7,000m**

In order to minimize the impacts of pile driving, BOEMRE will require developers to implement several mitigation measures as a part of their lease. These measures are detailed Section 7.

Met tower construction noise could disturb normal behaviors (e.g., feeding) of marine fish. Behavioral effects may be incurred at ranges of many miles, and hearing impairment may occur at close range (Madsen et al. 2006). As discussed in the impacts from HRG survey, behavioral reactions may include avoidance of, or flight from, the sound source and its immediate surroundings, and disruption of feeding behavior. Fish that don't flee the immediate action area during the soft-start pile driving procedure could be exposed to terminal sound pressure levels.

4.5 Benthic Effects

Sub-bottom Sampling
The sub-bottom sampling will result in small areas of the seafloor being disturbed, either at the bore hole, grab-sampled area, or associated with the vessel anchor placements. It is likely that the duration of activity at any one coring location would be no more than a couple of days (see Section 3.3.4.1). The sub-bottom sampling would result in a negligible temporary loss of some benthic organisms (i.e., less than one foot diameter will be disturbed in the areas where cores are sampled), and a localized increase in disturbance due to vessel activity, including noise and anchor cable placement and retrieval. This activity could impact marine fish by removing a small amount of forage items for these species. However, due to the small footprint, the temporary nature of the action, and likely availability of similar benthic habitat around the sampling location, it is expected that this activity will have negligible benthic effects that could impact federally-managed fish species that may occur in the mid-Atlantic WEAs.

Met Tower/Met Buoy Installation
The installation of a met buoy and the construction of a met tower will have benthic effects that are temporary in nature. It is anticipated that there would be some sediment that would become suspended around deployed anchoring systems and around monopoles resulting from the installation activity. This sediment would be dispersed and settle on the surrounding seafloor. Depending upon the currents this could potentially smother some benthic organisms. However, as mentioned previously the mid-Atlantic bight is considered a high energy environment that sees much sediment transport in its natural state. It is expected that any sedimentation that would occur around an installed tower or buoy would have only minor temporary effects that could impact the habitat and food availability for federally-managed species.

Met Tower/Met Buoy Operation

It is expected that the installation of monopoles and large anchoring systems, that if introduced to soft sediments would introduce an artificial hard substrate that opportunistic benthic species that prefer such substrate could colonize. In addition, minor changes in species associated with softer sediments could occur due to scouring around the pilings (Hiscock et al. 2002). Certain fish species (e.g., tautog, black sea bass, Atlantic striped bass) would likely be attracted to the newly formed habitat complex, and fish population numbers in the immediate vicinity of the anchors and monopoles are likely to be higher than in surrounding waters away from the structures. However, a single met tower or buoy within a lease block is not expected to result in changes in local community assemblage and diversity nor the availability of habitat and forage items for ESA-listed species that could occur in the action area.

4.6 Discharge of Waste Materials and Accidental Fuel Leaks

A vessel collision with the meteorological towers or other vessels may result in the spillage of diesel. Vessels are expected to comply with U.S. Coast Guard (USCG) requirements relating to prevention and control of oil spills. Approximately 10 percent of vessel collisions with fixed structures on the OCS caused diesel spills.

Diesel fuel spills may also occur during a refueling of a generator used to power the meteorological tower's equipment and lights. If a diesel spill were to occur, it would be expected to dissipate very rapidly. Since diesel is light it would evaporate and biodegrade within a few days.

Fish could be exposed to operational discharges or accidental fuel releases from construction sites and construction vessels and to accidentally released solid debris. Operational discharges from construction vessels would be released into the open ocean where they would be rapidly diluted and dispersed, or collected and taken to shore for treatment and disposal. Sanitary and domestic wastes would be processed through on-site waste treatment facilities before being discharged overboard. Deck drainage would also be processed prior to discharge. Thus, waste discharges from construction vessels would not be expected to directly affect fish or their habitat.

Ingestion of, or entanglement with, solid debris can adversely impact fish. Fish that have ingested debris, such as plastic, may experience intestinal blockage, which in turn may lead to starvation, while toxic substances present in the ingested materials (especially in plastics) could lead to a variety of lethal and sub-lethal toxic effects. Entanglement in plastic debris can result in reduced mobility, starvation, exhaustion, drowning, and constriction of, and subsequent damage to, limbs caused by tightening of the entangling material. The discharge or disposal of solid debris into offshore waters from OCS structures and vessels is prohibited by the BOEMRE (30 CFR 250.300) and the USCG (MARPOL, Annex V, Public Law 100–220 [101 Statute 1458]). Thus, entanglement in or ingestion of OCS-related trash and debris by fish would not be expected during normal operations. Because of the very limited amount of vessel traffic and construction activity that might occur with construction and operation of a meteorological tower, the release of liquid wastes would occur infrequently and cease following completion of tower construction. The likelihood of an accidental fuel release would also be limited to the active construction and decommissioning periods of the site characterization. Impacts to fish and their habitat from the discharge of waste materials or the accidental release of fuels are expected to be minor.

4.7 Meteorological Tower and Buoy Decommissioning

The decommissioning of met towers and buoys is described in Section 3.6. This Section primarily addresses the decommissioning of a met tower, as it is more extensive than that of a met buoy.

Upon completion of site characterization, the meteorological tower would be removed and transported by barge to shore. During this activity, fish may be affected by noise and operational discharges as described for meteorological tower construction. Removal of the piles would be accomplished by cutting the piles (using mechanical cutting or high-pressure water jet) at a depth of 4.6 m (15 ft) below the seabed. Fish could be affected by noise during pile cutting. Only animals in the immediate vicinity of the characterization site (those that had not moved away from the area upon arrival of decommissioning vessels) would be expected to be affected during tower removal and transport, and pile cutting. Disturbance of fish during decommissioning is expected to be minor.

5.0 Natural and Unanticipated Events

There is a potential for natural and/or unanticipated events to cause impacts to the environment during site assessment activities. In the case of a natural event, a hurricane or severe storm may impact met towers or buoys at some time during the operation. Depending on the severity of the event, components of the facility could be damaged, destroyed, or cut loose resulting in temporary sea hazards until the device can either be retrieved, as in the case of a buoy, repaired, or removed. It should be noted that buoys have GPS systems that alert the investigators if they move beyond their operating area. Mariners would be notified immediately if this were to happen. Similar alerts would occur if a met tower were experience severe damage.

As with any structure placed the ocean, there is a chance that a vessel, other than a maintenance or construction vessel, could collide with the structure causing catastrophic damage to the vessel, tower or both. This type of collision is unanticipated since it would require a loss of vessel power or steerage, high winds or a sea state that would drive the vessel toward the structure, and failure of the vessel’s and/or structure’s design to withstand the impact. In the absence of these factors the current mitigation measures for placement outside of traffic lanes, lighting, and mariner notifications of structures should prevent collisions of this type from occurring. If an unanticipated collision were to occur, and a vessel’s cargo was discharged, the impacts would depend upon that of the type and amount of cargo discharged, whether oil, liquefied natural gas, chemicals, or other commodities.

6.0 Conclusions

The proposed action is anticipated to adversely impact the quality and quantity of fish essential fish habitat and the fish that are present. However, given the limited spatial extent and limited duration of the proposed activities, it is not likely that the impacts would be more than temporary and not substantially affect the populations of fish in the area. Although this first phase of the siting process has sought to identify mid-Atlantic WEAs of reduced use-conflict, the areas currently sustain various levels of disturbance, including fishery extractions and transits by vessels en route to major East Coast ports.

7.0 MITIGATION, MONITORING AND REPORTING REQUIREMENTS FOR ESA LISTED SPECIES

This section outlines the specific environmental mitigation, monitoring and reporting measures built into the proposed action to minimize or eliminate potential environmental impacts. Although a majority of the measures are directed at ESA-listed species these mitigations also facilitate reduced impacts to non ESA-listed species including marine fish. Modifications to these stipulations may be made during the leasing process if comments or new data indicate that changes are necessary and conditions warrant change. Additional mitigation, monitoring or reporting measures may be included in any issued BOEMRE lease or other authorization, including those that may be developed during statutory consultations with State and Federal agencies.

7.1. Measures for ESA-Listed Marine Mammals and Sea Turtles

The following measures are part of the proposed action and are meant to minimize or eliminate the potential for adverse impacts to ESA-listed marine mammals and sea turtles. These mitigations also facilitate reduced impacts to ESA-listed marine fish and non-ESA listed marine mammals, sea turtles, and marine fish. They are divided into five sections: (1) those required during all phases of the project; (2) those required during pre-construction site assessment: (3) those required during construction; (4) those required during operation/maintenance; and (5) those required during decommissioning. These measures and those that may be ultimately be required through the ESA consultation process will be addressed through the inclusion of stipulations in BOEMRE leases and/or authorizations, if issued, for the proposed activities.

7.1.1 Requirements for All Phases of Project

As noted in Section 4 of this BA, the proposed action will temporarily increase the number of vessels and vessel traffic within the WEAs and in the route between the WEAs and port facilities. Section 4.4 of the BA provides detail on the vessel and aircraft activity associated with the proposed action.

The following specific measures are meant to reduce the potential for vessel harassments or collisions with listed marine mammals or sea turtles during all phases of the project.

- All vessels and aircraft whose operations are authorized under or regulated by the terms of a BOEMRE-issued renewable energy lease will be required to abide by the NOAA Fisheries Northeast Regional Viewing Guidelines, as updated through the life of the project (http://www.nmfs.noaa.gov/pr/pdfs/education/viewing_northeast.pdf).
- All vessels whose operations are authorized under or regulated by the terms of a BOEMRE-issued renewable energy lease will be required to abide by the BOEMRE Gulf of Mexico Region's Notice to Lessee (NTL) No. 2007-G04 (http://www.gomr.mms.gov/homepg/regulate/regs/ntls/2007NTLs/07-g04.pdf). Please note the NMFS Northeast Region, the appropriate Region for the activity in the mid-Atlantic WEAs, marine mammal entanglement hotline is: 800-900-3622. General vessel strike avoidance measures from the NTL include:

    - Vessel operators and crews must maintain a vigilant watch for marine mammals and sea turtles and slow down or stop their vessel to avoid striking protected species.
    - When whales are sighted, maintain a distance of 100 yards (91 meters) or greater from the whale. If the whale is believed to be a North Atlantic right whale, you must maintain a minimum distance of 500 yards (457 meters) from the animal (50 CFR 2224.103).
    - When sea turtles or small cetaceans are sighted, you must maintain a distance of 50 yards (45 meters) or greater whenever possible.
    - When cetaceans are sighted while a vessel is underway, you must remain parallel to the animal's course whenever possible. You must avoid excessive speed or abrupt changes in direction until the cetacean has left the area.
- All vessel operators must comply with vessel strike reduction measures for North Atlantic right whales implemented by NMFS, including Special Management Areas (SMAs) and Dynamic Management Areas (DMAs). Adherence to vessel restrictions in DMAs is not voluntary for vessels operating under authorizations or regulations under the terms of a BOEMRE-issued renewable energy lease. Compliance documents are located at: http://www.nero.noaa.gov/shipstrike/.
- The Federal Aviation Administration (FAA) regulates helicopter flight patterns. Because of noise concerns, FAA Circular 91-36D encourages pilots making flights near noise-sensitive areas to fly at altitudes higher than minimum altitudes near noise-sensitive areas (http://www.fs.fed.us/r10/tongass/districts/admiralty/packcreek/AC91-36d.pdf). You must avoid noise-sensitive areas, unless doing so would be impractical or unsafe. Pilots operating noise producing aircraft over noise-sensitive areas must fly not less than 2,000 feet above ground level, weather permitting, unless doing so would be impractical or unsafe. Departure from or arrival to an airport, climb after take-off, and descent for landing must be made so as to avoid prolonged flight at low altitudes near noise-sensitive areas. In addition, guidelines and regulations issued by National Marine Fisheries Service (NMFS) under the authority of the Marine Mammal Protection Act (MMPA) include provisions specifying helicopter pilots to maintain an altitude of at least 1,000 ft within sight of marine mammals.
- All vessel and aircraft (where applicable) operators must be briefed to ensure they are familiar with the above requirements. Adherence to these requirements must be written into any contractor agreements.
- All vessel operators, employees and contractors actively engaged in offshore operations must be briefed on marine trash and debris awareness elimination as described in the BOEMRE Gulf of Mexico Region's NTL No. 2007-G03 (http://www.gomr.mms.gov/homepg/regulate/regs/ntls/2007NTLs/07-g03.pdf), except that BOEMRE will not require the applicant to undergo formal training or post placards, as described under this NTL. The applicant must ensure that its employees and contractors are made aware of the environmental and socioeconomic impacts associated with marine trash and debris and their responsibilities for ensuring that trash and debris are not intentionally or accidentally discharged into the marine environment. The above referenced NTL provides information the applicant may use for this awareness training.

7.1.2. Requirements During Pre-Construction Site Assessment Surveys

Section 3 of this assessment describes the pre-construction high-resolution site surveys and sub-bottom sampling the applicant would likely undertake should BOEMRE issue the proposed leases. These field investigations would be conducted prior to construction.

The following mitigation, monitoring and reporting requirements will be implemented during the conduct of all high-resolution geophysical survey work.

- *Establishment of Exclusion Zone*: A 500 m (1640 ft) radius exclusion zone for listed marine mammals and sea turtles will be established around the seismic survey source vessel in order to reduce the potential for serious injury or mortality of these species.
- *Visual Monitoring of Exclusion Zone*: Monitoring of the zones will be conducted by a qualified NMFS-approved observer. Visual observations will be made using binoculars or other suitable equipment during daylight hours. Data on all observations will be recorded based on standard marine mammal observer collection data. This will include: dates and locations of construction operations; time of observation, location and weather; details of marine mammal sightings (e.g., species, numbers, behavior); and details of any observed taking (behavioral disturbances or injury/mortality). Any significant observations concerning impacts on listed marine mammals or sea turtles will be transmitted to NMFS and BOEMRE within 48 hours. Any observed takes of listed marine mammals or sea turtles resulting in injury or mortality will be immediately (within 24 hours) reported to NMFS and BOEMRE.

  Visual monitoring will begin no less than 30 minutes prior to the beginning of ramp-up and continue until seismic operations cease or sighting conditions do not allow observation of the sea surface (e.g., fog, rain, darkness). If a marine mammal or sea turtle is observed, the observer should note and monitor the position (including lat./long. of vessel and relative bearing and estimated distance to the animal) until the animal dives or moves out of visual range of the observer. You must continue to observe for additional animals that may surface in the area, as often there are numerous animals that may surface at varying time intervals. At any time a whale is observed within an estimated 500 meters (1,640 feet) of the sound source array ("exclusion zone"), whether due to the whale's movement, the vessel's movement, or because the whale surfaced inside the exclusion zone, the observer will call for the immediate shut-down of the seismic operation. The vessel operator must comply immediately with such a call by an on-watch visual observer. Any disagreement or discussion should occur only after shut-down. When no marine mammals or sea turtles are sighted for at least a 30-minute period, ramp-up of the sound source may begin. Ramp-up cannot begin unless conditions allow the sea surface to be visually inspected for marine mammals and sea turtles for 30 minutes prior to commencement of ramp-up. Thus, ramp-up cannot begin after dark or in conditions that prohibit visual inspection (fog, rain, etc.) of the exclusion zone. Any shut-down due to a whale(s) sighting within the exclusion zone must be followed by a 30-minute all-clear period and then a standard, full ramp-up. Any shut-down for other reasons, including, but not limited to, mechanical or electronic failure, resulting in the cessation of the sound source for a period greater than 20 minutes, must also be followed by full ramp-up procedures. In recognition of occasional, short periods of the cessation of survey equipment for a variety of reasons, periods of silence not exceeding 20 minutes in duration will not require ramp-up for the resumption of seismic operations if: (1) visual surveys are continued diligently throughout the silent period (requiring daylight and reasonable sighting conditions), and (2) no whales, other marine mammals, or sea turtles are observed in the exclusion zone. If whales, other marine mammals, or sea turtles are observed in the exclusion zone during the short silent period, resumption of seismic survey operations must be preceded by ramp-up.

- *Implementation of Ramp-Up*: A "ramp-up" (if allowable depending on specific sound source) will be required at the beginning of each seismic survey in order to allow marine mammals and sea turtles to vacate the area prior to the commencement of activities. Seismic surveys may not commence (i.e., ramp up) at night time or when the exclusion zone cannot be effectively monitored (i.e., reduced visibility).
- *Shut Down*: Continuous (day and night) seismic survey operations will be allowed if sufficient lighting is provided to monitor the 500m exclusion zone. If sufficient lighting is not available, survey activity must be limited to daylight hours. If a listed marine mammal or sea turtle is spotted within or transiting towards the exclusion zone surrounding the sub-bottom profiler and the survey vessel, an immediate shutdown of the equipment will be required. Subsequent restart of the profiler may only occur following clearance of the exclusion zone and the implementation of ramp up procedures (if applicable).
- *Compliance with Equipment Noise Standards*: All seismic surveying equipment must comply as much as possible with applicable equipment noise standards of the U.S. Environmental Protection Agency.
- *Reporting for Seismic Surveys Activities*: The following reports must be submitted during the conduct of seismic surveys:
    - A report must be provided to BOEMRE and NMFS within 90 days of the commencement of seismic survey activities that includes a summary of the seismic surveying and monitoring activities and an estimate of the number of listed marine mammals and sea turtles that may have been taken as a result of seismic survey activities. The report will include information, such as: dates and locations of operations, details of listed marine mammal or sea turtle sightings (dates, times, locations, activities, associated seismic activities), and estimates of the amount and nature of listed marine mammal or sea turtle takings.
    - Any observed injury or mortality to a listed marine mammal or sea turtle must be reported to NMFS and BOEMRE immediately (within 24 hours). Any significant observations concerning impacts on listed marine mammals or sea turtles will be transmitted to NMFS and BOEMRE within 48 hours.

The following mitigation, monitoring and reporting requirements will be implemented during the conduct of all sub-bottom sampling work.

- *Establishment of Exclusion Zone*: A 200 m radius exclusion zone for listed marine mammals and sea turtles must be established around any vessel conducting the sub-bottom sampling in order to reduce the potential for serious injury or mortality of these species.
- *Visual Monitoring of Exclusion Zone*: The exclusion zone around the vessel must be monitored for the presence of listed marine mammals or sea turtles using the protocol detailed above for HRG survey work absent ramp-up procedures.

7.1.3 Requirements During Construction of Meteorological Towers

Acoustic harassment from construction activities hold the greatest potential for disturbance. Section 4 of this BA describes the pile driving process in detail. Section 4.0 of this assessment outlines the potential effects of pile driving activities on listed marine mammals and sea turtles.

BOEMRE has included the following specific measures as part of the proposed action and these are meant to reduce or eliminate the potential for adverse impacts on listed marine mammals or sea turtles during the construction phase of the project:

Pre-Construction Briefing: Prior to the start of construction, the Lessee(s) must hold a briefing to establish responsibilities of each involved party, define the chains of command, discuss communication procedures, provide an overview of monitoring purposes, and review operational procedures. This briefing must include construction supervisors and crews, the marine mammal and sea turtle visual observer(s) (see further below). The Resident Engineer (or other authorized individual) will have the authority to stop or delay any construction activity, if deemed necessary. New personnel must be briefed as they join the work in progress.

Requirements for Pile Driving: The following measures will be implemented during the conduct of pile driving activities related to meteorological towers:

- *Establishment of Exclusion Zone*: A preliminary 7 km radius exclusion zone for listed marine mammals and sea turtles must be established around each pile driving site in order to reduce the potential for serious injury or mortality of these species. The 7 km exclusion zone is based upon the field of ensonification at the 160dB level. The 7 km exclusion zone must be monitored from two locations. One observer must be based at or near the sound source and responsible for monitoring the 180 dB field of ensonification out to 1000m from the sound source. An additional observer must be located on a separate vessel navigating approximately 4-5 kms around the pile hammer monitoring 360° out to 7km from the sound source. If multiple piles are being driven, the field verification method may be used to modify the exclusion zone. Any new exclusion zone radius must be based on the most conservative measurement (i.e., the largest safety zone configuration), include an additional 'buffer' area extending out of the 160 dB zone, and be approved by BOEMRE and NMFS before implementing. Once approved, this zone must be used for all subsequent pile driving and be periodically re-evaluated based on the regular sound monitoring described in the Field Verification of Exclusion Zone section described below.
- *Field Verification of Exclusion Zone*: Field verification of the exclusion zone must take place during pile driving of the first pile if the meteorological tower design includes multiple piles. The results of the measurements from the first pile must be used to establish a new exclusion zone which may be greater than or less than the 7 km default exclusion zone depending on the results of the field tests. Acoustic measurements must take place during the driving of the last half (deepest pile segment) for any given open-water pile. Two reference locations must be established at a distance of 500m and 5 km from the pile driving. Sound measurements must be taken at the reference locations at two depths (a depth at mid-water and a depth at approximately 1m above the seafloor). Sound pressure levels must be measured and reported in the field in dB re 1 μPa rms

- *Visual Monitoring of Exclusion Zone*: Monitoring of the zones must be conducted by a qualified NMFS-approved observer. Visual observations must be made using binoculars or other suitable equipment during daylight hours. Data on all observations must be recorded based on standard marine mammal observer collection data. This must include: dates and locations of construction operations; time of observation, location and weather; details of marine mammal sightings (e.g., species, numbers, behavior); and details of any observed taking (behavioral disturbances or injury/mortality). Any significant observations concerning impacts on listed marine mammals or sea turtles must be transmitted to NMFS and BOEMRE within 48 hours. Any observed takes of listed marine mammals or sea turtles resulting in injury or mortality will be immediately (within 24 hours) reported to NMFS and BOEMRE.

  Visual monitoring must begin no less than 30 minutes prior to the beginning of soft start and continue until pile driving operations cease or sighting conditions do not allow observation of the sea surface (e.g., fog, rain, darkness). If a marine mammal or sea turtle is observed, the observer must note and monitor the position, relative bearing and estimated distance to the animal until the animal dives or moves out of visual range of the observer. You must continue to observe for additional animals that may surface in the area, as often there are numerous animals that may surface at varying time intervals.

  At any time a whale is observed within the exclusion zone, whether due to the whale's movement, the vessel's movement, or because the whale surfaced inside the exclusion zone, the observer must notify the Resident Engineer (or other authorized individual). BOEMRE recognizes that once the pile driving of a segment begins it cannot be stopped until that segment has reached its predetermined depth. If pile driving stops and then resumes, it would potentially have to occur for a longer time and at increased energy levels. In sum, this would simply amplify impacts to listed marine mammals and sea turtles, as they would endure potentially higher SPLs for longer periods of time. If listed marine mammals or sea turtles enter the zone after pile driving of a segment has begun, pile driving may continue and observers must monitor and record listed marine mammal and sea turtle numbers and behavior. However, if pile driving of a segment ceases for 30 minutes or more and a listed marine mammal or sea turtle is sighted within the designated zone prior to commencement of pile driving, the observer(s) must notify the Resident Engineer (or other authorized individual) that an additional 30 minute visual and acoustic observation period will be completed, as described above, before restarting pile driving activities. In addition, pile driving may not begin during night hours or when the safety radius can not be adequately monitored (i.e., obscured by fog, inclement weather, poor lighting conditions) unless the applicant implements an alternative monitoring method that is agreed to by BOEMRE and NMFS. However, if a soft start has been initiated before dark or the onset of inclement weather, the pile driving of that segment may continue through these periods. Once that pile has been driven, the pile driving of the next segment cannot begin until the exclusion zone can be visually or otherwise monitored.

- *Implementation of Soft Start*: A "soft start" must be implemented at the beginning of each pile installation in order to provide additional protection to listed marine mammals and sea turtles near the project area by allowing them to vacate the area prior to the commencement of pile driving activities. The soft start requires an initial set of 3 strikes from the impact hammer at 40-percent energy with a one minute waiting period between subsequent 3-strike sets. If listed marine mammals or sea turtles are sighted within the exclusion zone prior to pile-driving, or during the soft start, the Resident Engineer (or other authorized individual) must delay pile-driving until the animal has moved outside the exclusion zone.
- *Compliance with Equipment Noise Standards*: All construction equipment must comply as much as possible with applicable equipment noise standards of the U.S. Environmental Protection Agency, and all construction equipment must have noise control devices no less effective than those provided on the original equipment.
- *Reporting for Construction Activities*: The following reports must be submitted during construction:
    - Data on all observations must be recorded based on standard marine mammal observer collection data. This must include: dates and locations of construction operations; time of observation, location and weather; details of marine mammal sightings (e.g., species, numbers, behavior); and details of any observed taking (behavioral disturbances or injury/mortality). Any significant observations concerning impacts on listed marine mammals or sea turtles will be transmitted to NMFS and BOEMRE within 48 hours. Any observed takes of listed marine mammals or sea turtles resulting in injury or mortality will be immediately (within 24 hours) reported to NMFS and BOEMRE.
    - A final technical report within 120 days after completion of the pile driving and construction activities must be provided to BOEMRE and NMFS, and that provides full documentation of methods and monitoring protocols, summarizes the data recorded during monitoring, estimates the number of listed marine mammals and sea turtles that may have been taken during construction activities, and provides an interpretation of the results and effectiveness of all monitoring tasks.

7.2 Measures for ESA-Listed Birds and Bats

The measures below are part of the proposed action and are meant to minimize or eliminate the potential for adverse impacts to ESA-listed birds during all phases of the project (i.e., construction, operations/maintenance, decommissioning). These measures, and those that may ultimately be required through the ESA consultation process, will be included as requirements in any BOEMRE authorization, if issued, for the proposed activity.

7.2.1 Mitigation and Monitoring Specific to the Design and Operation of the Project

The following mitigation measures represent requirements which would be implemented in BOEMRE leases, if issued, for the proposed projects. These measures are directly related to requirements for the meteorological towers and/or buoys.

- *Anti-Perching*: Lessees must use anti-perching devices on met towers and buoys to the extent practicable.
- *Guy Wires*: No guy wires are prohibited.

- *Lighting*: Certain types of lighting on tall, man-made structures increases the risk of collision during periods of fog or rain when birds may become disoriented by artificial light sources. There have been substantial bird collisions with communication towers reported in the U.S. (Shire et al., 2000), particularly with tall communication towers (at heights greater than 305 m [1,000 ft]), guy wires, and steady-burning lights (Gehring et al 2009). Obstruction lights will be installed in compliance with the Federal Aviation Administration (FAA) guidelines and U.S. Coast Guard (USCG) navigational safety lighting requirements. The USCG lighting for navigation safety consists of two amber lights (USCG Class C) mounted on the platform deck. In accordance with FAA guidelines, the tower would be equipped with a light system consisting of a low intensity flashing red light (FAA designated L-864) for night use.
    - It is understood that construction structures and equipment may be lit at night. BOEMRE will require that the applicant leave construction lights on only when necessary and downshield when possible, including support vessel lighting.
    - *Reporting of Bird Fatalities*: All federal and state listed avian fatalities due to collisions with vessels, aircraft, or structures will be documented and reported within 24 hrs to BOEMRE and FWS. Fatalities of non-listed and migratory bird species will be reported annually to BOEMRE and FWS as stipulated in by standard FWS salvage permits.

7.3 Requirements During Decommissioning

Section 4 of this BA contains detail on the proposed methodology for decommissioning and removal of the met towers and buoys. Essentially, the decommissioning process is the reverse of the construction process (absent pile driving), and the impacts from decommissioning would likely mirror those of construction. In addition, vessel activity during decommissioning would be essentially the same as that required during construction. Therefore, the vessel and aircraft mitigation measures outlined in section 8.1.1 of this BA will be required.

Foundation structures must be removed by cutting at least 4.6 m (15 ft) below grade. Depending on the capacity of the available crane, the monopile or jacket may be cut once or may be cut into several pieces.

BOEMRE assumes the metrological towers to be constructed in the mid-Atlantic can be removed using non-explosive severing methods. Issuance of a lease would not constitute the approval of explosive severing methods. If a lessee intends to use explosive severing methods then a detailed decommissioning plan must be submitted to BOEMRE for approval, in addition to any other requirements described in the lease instrument. Proposed use of explosives may require supplemental NEPA analysis and re-initiation of relevant consultations. The Decommissioning Plan must include the following information in form and content satisfactory to BOEMRE:

- A brief description of the severing method to be used.
- If divers or acoustic devices will be used to conduct a pre-removal survey to detect the presence of turtles and marine mammals, a description of the proposed detection method;
- A statement whether or not transducers will be used to measure the pressure and impulse of any planned detonations.

- A noise analysis of the proposed decommissioning activities including a project-specific estimate of the sound levels that are likely to be generated from the use as a function of pulse intensity and distance from source.
- If available, the results of any recent biological surveys conducted in the vicinity of the structure and recent observations of turtles or marine mammals at the structure site.
- Lessee's plans to protect archaeological and sensitive biological features during removal operations, including a brief assessment of the environmental impacts of the removal operations and procedures and mitigation measures you will take to minimize such impacts.
- A statement whether or not divers will be used to survey the area after removal to determine any effects on marine life.
- Any other information reasonably requested by BOEMRE to ensure Lessee's activities on the OCS are conducted in a safe and environmentally sound manner.

7.4 Other Non-ESA Related Mitigation Measures and Reporting Requirements

- *Monitoring of met tower foundations*: Met tower foundation and scour protection must be monitored every 3 months the first year of the structure and then every year afterwards. The purpose of this monitoring is to check for evidence of scour, monitoring artificial seagrass fronds (if used) for evidence that they are being consumed by sea turtles or marine mammals, and evidence of habitat alteration due to the introduction of hard structure into the environment. If there is evidence that the scour mats are being consumed by sea turtles or marine mammals, NMFS and BOEMRE will determine further mitigation and monitoring measures.
- *Navigation*: The project developer must ensure that all fixed structures including buoys and met towers are properly marked with Private Aids to Navigation (PATON) and coordinate with USCG in publicizing a Notice to Mariners in regards to construction activity and significant vessel operations.
- *Inspections*: As would be required by the lease instrument, the project developer must allow prompt access to any authorized Federal inspector to the site of any activities conducted pursuant to the lease. These inspections may include annual scheduled inspections and periodic unscheduled (unannounced) inspections to assure compliance with the lease and applicable regulations
- *General Reporting*: The results of site characterization activities must be provided to BOEMRE in the submission of the Construction and Operations Plan (COP) if not requested and/or submitted previously. Elements to be appended to the COP include:
    - A summary of monitoring activities and an estimate of the number of listed marine mammals and sea turtles that may have been taken as a result of pile driving activities. These reports will include information, such as: dates and locations of construction operations, details of listed marine mammal or sea turtle sightings (dates, times, locations, activities, associated construction activities), and estimates of the amount and nature of listed marine mammal or sea turtle takings.
    - All studies, surveys, inspections, or test reports compiled or completed during the duration of a lease and the raw data and analyses used to interpret such data.
    - A report must be provided to BOEMRE and NMFS detailing the field verification measurements. This includes information, such as: a fuller account of the levels,

7.5 Site Characterization Data Collection

In addition to the collection of meteorological and oceanographic data, the purpose of these met towers/buoys and site characterization surveys are to also collect biological and archaeological data. This data will assist in future analysis of proposed wind facilities. In addition to required reports, all site characterization data will be shared with NMFS, FWS, and appropriate State agencies, upon request.

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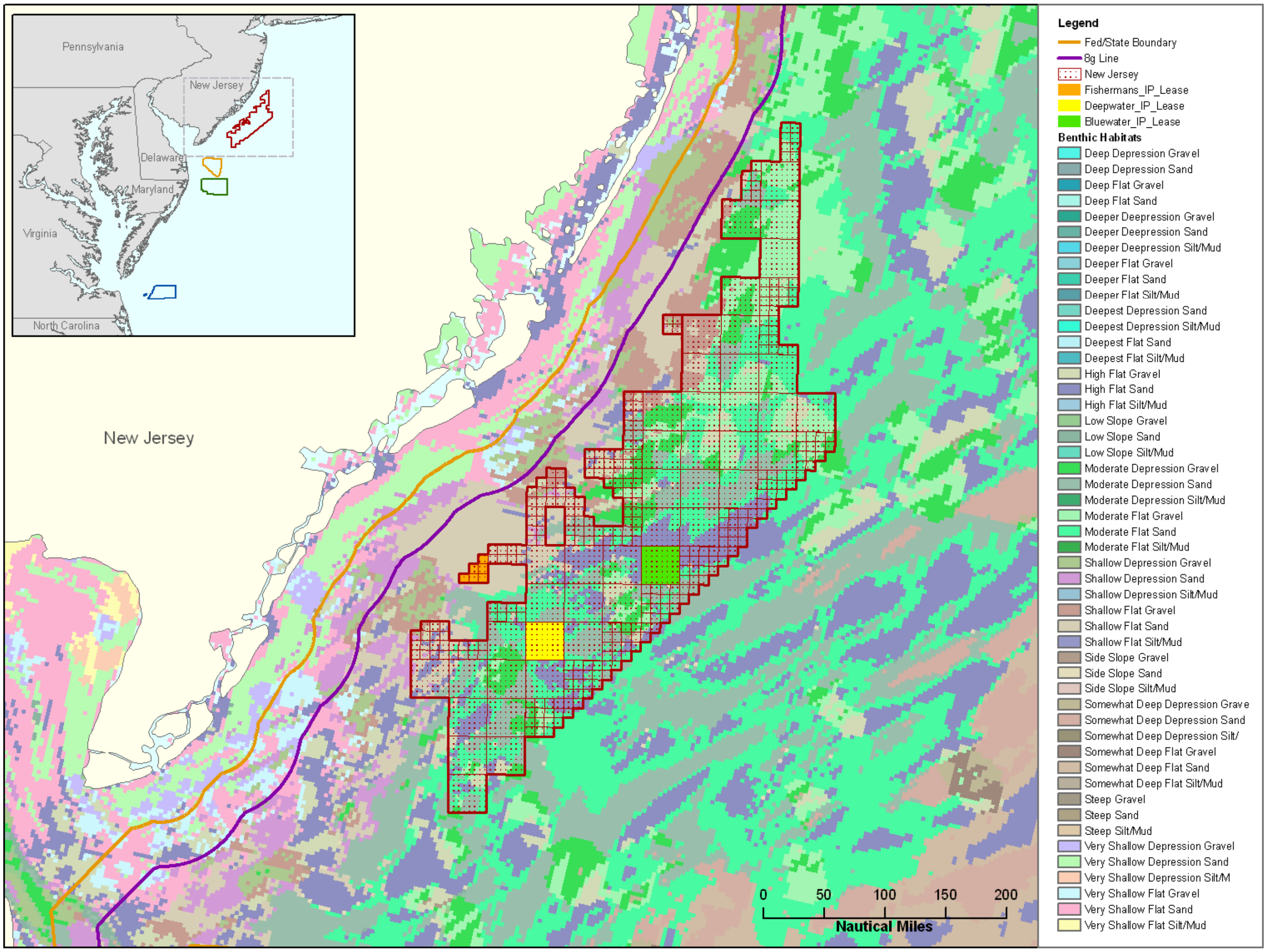
Appendix 1. Benthic Habitat

Figure 1. Benthic habitat types within the New Jersey WEA (from TNC 2011).



Map ID: ERB-2011-1001

Figure 2. Benthic habitat types within the Delaware and Maryland WEAs (from TNC 2011).

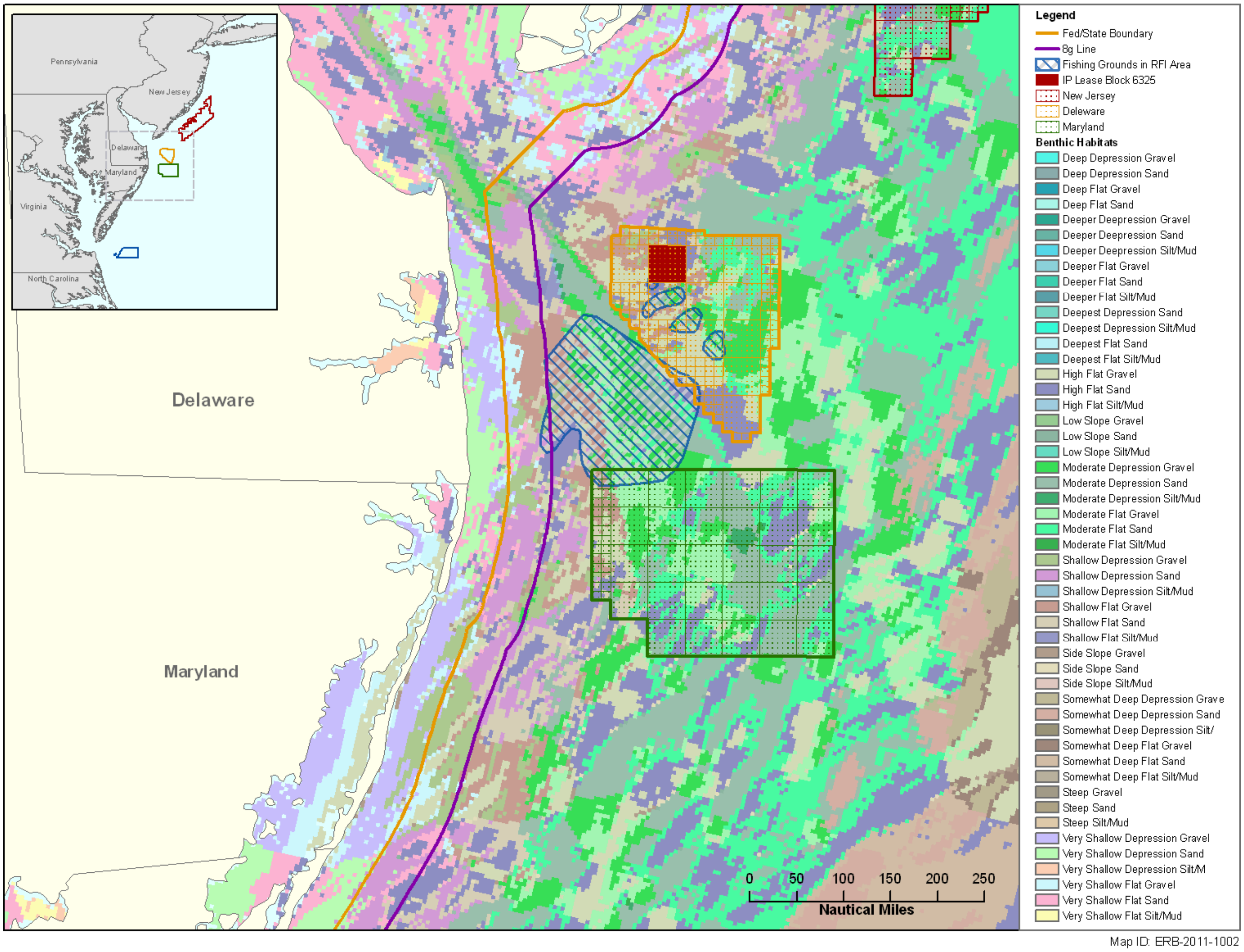
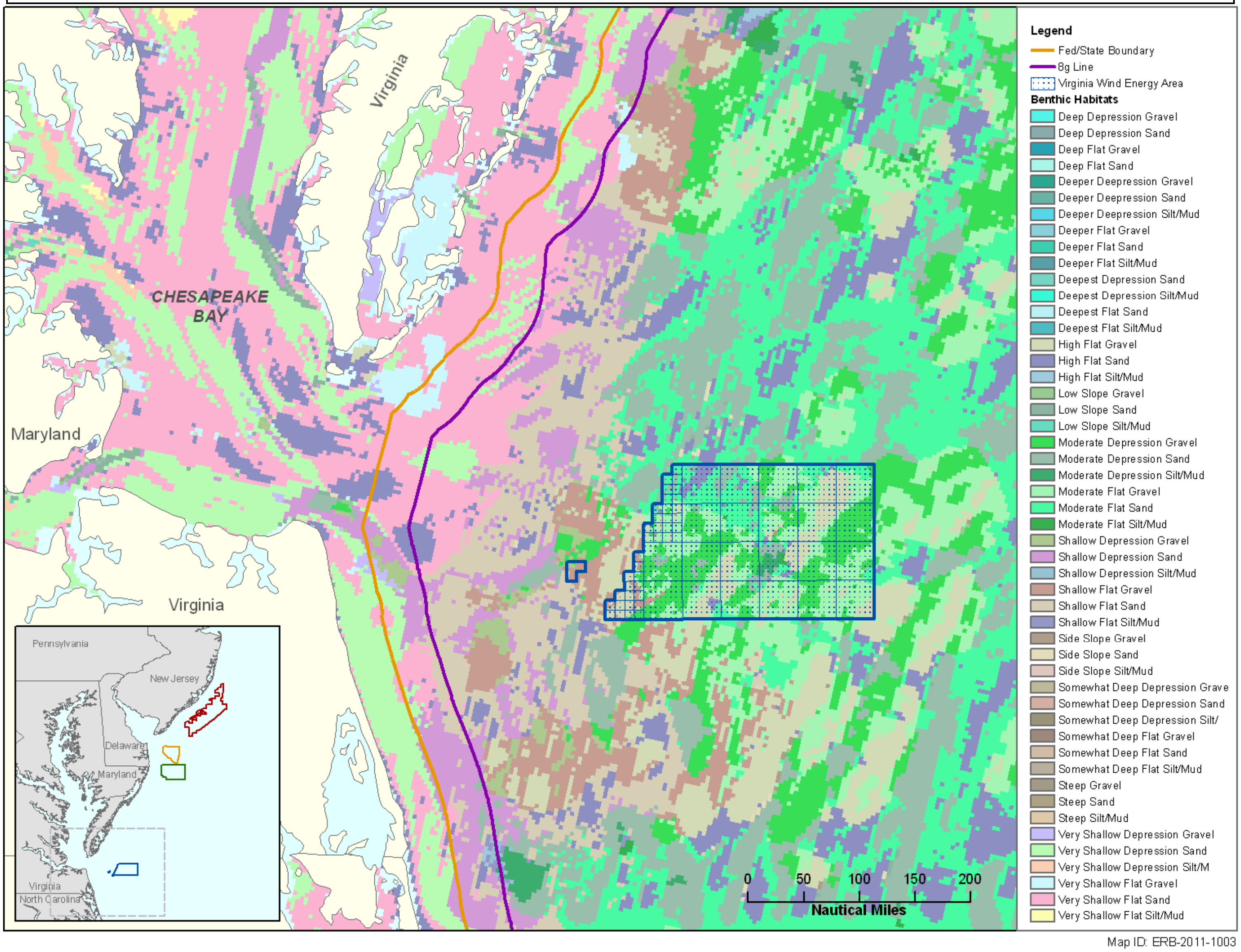
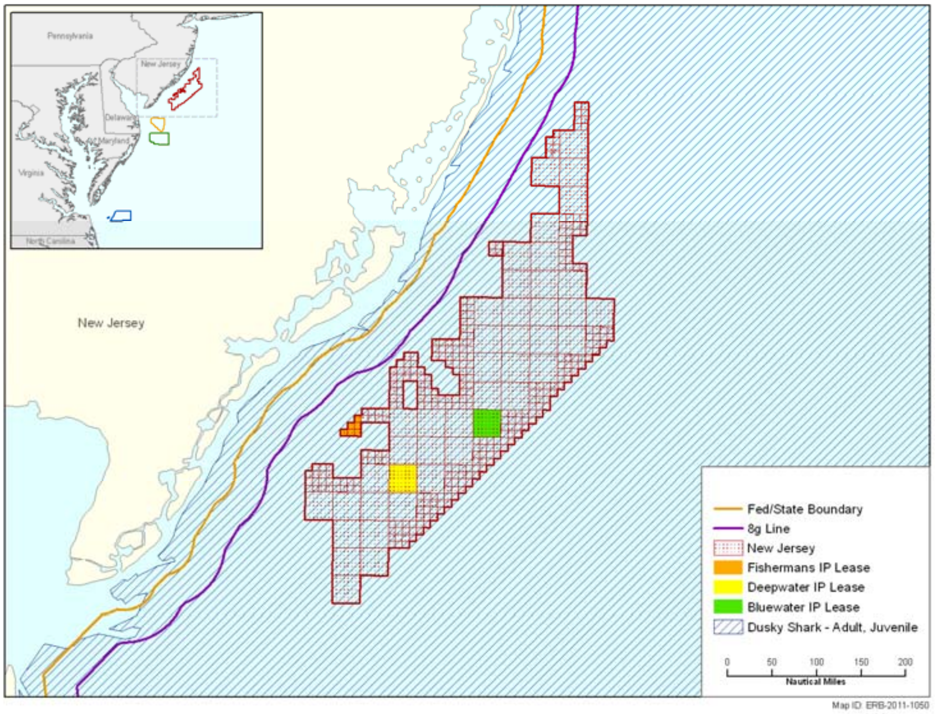


Figure 3. Benthic habitat types within the Virginia WEA (from TNC 2011).



Appendix 2. Selected Essential Fish Habitat Designations

Figure 1. Dusky and tiger shark EFH designations off New Jersey.



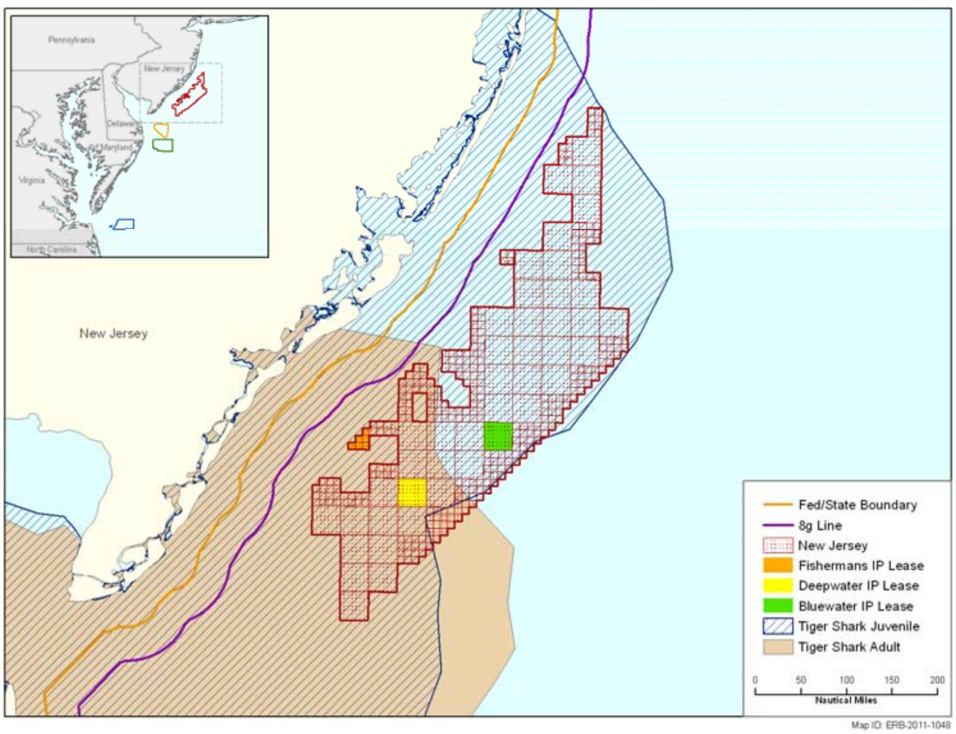
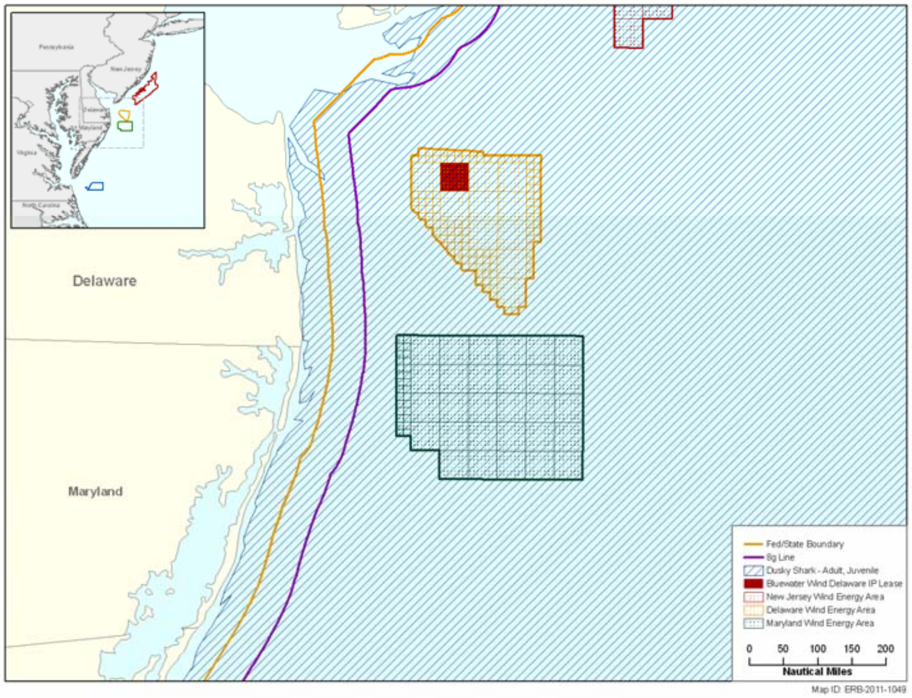


Figure 2. Dusky and tiger shark EFH designations off DE and MD.



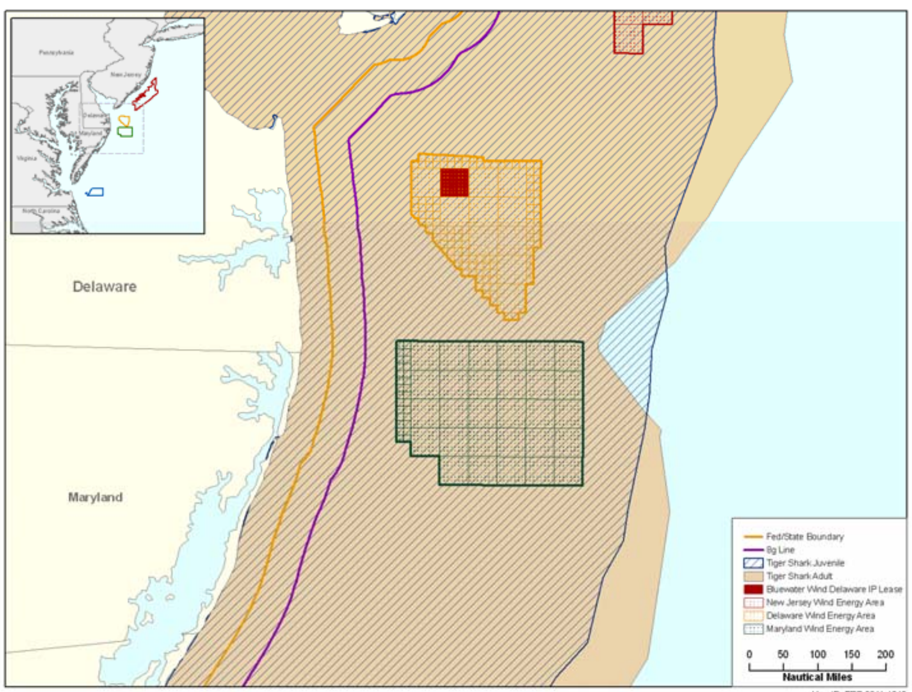


Figure 3. Dusky and tiger shark EFH designations off Virginia.