Biological 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

Biological Assessment

Bureau of Ocean Energy Management Regulation and Enforcement

March 24, 2011

Table of Contents

1.0 INTRODUCTION **1**

2.0 ENDANGERED SPECIES ACT CONSULTATION HISTORY **2**

3.0 THREATENED AND ENDANGERED SPECIES IN THE PROPOSED ACTION AREA **3**

3.1 MARINE MAMMALS 3
3.2 SEA TURTLES 9
3.3 MARINE FISH 11
3.4 BIRDS 13
3.5 BATS 15

4.0 PROPOSED ACTION **16**

4.1 OVERVIEW 16
4.2 DESCRIPTION OF WIND ENERGY AREAS 16

4.3 SITE CHARACTERIZATION SURVEYS **19**

4.3.1 HIGH-RESOLUTION GEOPHYSICAL (HRG) SURVEY 19
4.3.1.1 HRG SURVEY INSTRUMENTATION 20
4.3.1.2 PROPOSED HRG SURVEY ACTION SCENARIO 21
4.3.2 BIOLOGICAL RESOURCE SURVEY 22
4.3.3 CULTURAL RESOURCE SURVEY 22
4.3.4 SUB-BOTTOM RECONNAISSANCE 22
4.3.4.1 SUB-BOTTOM RECONNAISSANCE SCENARIO 23
4.3.5 SITE ASSESSMENT 24
4.3.5.1 PROPOSED ACTION SCENARIO 24
4.3.5.2 METEOROLOGICAL TOWER 25
4.3.5.3 METEOROLOGICAL BUOYS 32
4.3.5.4 TIMING OF WIND RESOURCE ASSESSMENT EQUIPMENT INSTALLATION 38

4.4 VESSEL TRAFFIC **38**

4.5 ONSHORE ACTIVITY **41**

4.6 DECOMMISSIONING **42**

4.6.1 CUTTING AND REMOVING PILES 43
4.6.2 REMOVAL OF SCOUR CONTROL SYSTEM 43

4.6.3 DISPOSAL **44**

4.6.4 ARTIFICIAL REEFS **44**

5.0 EFFECTS OF THE PROPOSED ACTION **44**

5.1 DESCRIPTION OF THE ENVIRONMENT **44**

5.2 ACOUSTIC EFFECTS **45**

5.2.1 CURRENT UNDERSTANDING OF NOISE SENSITIVITY IN MARINE FAUNA 45
5.2.2 HIGH RESOLUTION GEOLOGIC SURVEY ACOUSTIC EFFECTS 50
5.2.3 SUB-BOTTOM RECONNAISSSANCE ACOUSTIC EFFECTS 54
5.2.4 MET TOWER PILE-DRIVING NOISE 54
5.2.5 VESSEL TRAFFIC NOISE 58

5.3 BENTHIC EFFECTS **59**

5.4 COLLISION EFFECTS **60**

5.5 LIGHTING EFFECTS **62**

5.6 DISCHARGE OF WASTE MATERIALS AND ACCIDENTAL FUEL LEAKS **62**

5.7 METEOROLOGICAL TOWER AND BUOY DECOMMISSIONING **65**

6.0 NATURAL AND UNANTICIPATED EVENTS **66**

7.0 CONCLUSIONS **66**

CONCLUSIONS –MARINE MAMMALS 66
CONCLUSION – MARINE FISH 67
CONCLUSION – AVIFAUNA 67

8.0 MITIGATION, MONITORING AND REPORTING REQUIREMENTS FOR ESA LISTED SPECIES **67**

8.1. MEASURES FOR ESA-LISTED MARINE MAMMALS AND SEA TURTLES **67**

8.1.1 REQUIREMENTS FOR ALL PHASES OF PROJECT 67
8.1.2. REQUIREMENTS DURING PRE-CONSTRUCTION SITE ASSESSMENT SURVEYS 69
8.1.3 REQUIREMENTS DURING CONSTRUCTION OF METEOROLOGICAL TOWERS 71

8.2 MEASURES FOR ESA-LISTED BIRDS AND BATS **74**

8.2.1 MITIGATION AND MONITORING SPECIFIC TO THE DESIGN AND OPERATION OF THE PROJECT 74

8.3 REQUIREMENTS DURING DECOMMISSIONING **74**

8.4 OTHER NON-ESA RELATED MITIGATION MEASURES AND REPORTING REQUIREMENTS **75**

8.5 SITE CHARACTERIZATION DATA COLLECTION **76**

9.0 REFERENCES **76**

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 a biological assessment (BA) of the 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. The regional EA 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.

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, including the Marine Mammal Protection Act (MMPA) as specifically required by 30 CFR §285.801(b). 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 Endangered Species Act Consultation History

The proposed activity is similar in many respects to the consultation for Wind Resource Data Collection on the Northeast Atlantic Outer Continental Shelf (OCS) that was concluded in the Spring of 2009. However, 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 assessment include: geological and geophysical surveys (sonar and sediment work), wind resource assessments (meteorological towers and buoys), biological assessments, and cultural/archeological assessments.

NOAA's National Marine Fisheries Service (NMFS)

On May 1, 2009, BOEMRE initiated consultation with NMFS for "Non-Competitive Lease for Wind Resource Data Collection on the Northeast Outer Continental Shelf." This consultation evaluated the issuance of several interim policy (IP) leases for wind resource data collection, including geological and geophysical (G&G) site assessment surveys. These IP leases were concentrated off of Delaware and New Jersey. The consultation was concluded in a May 14, 2009, letter from NMFS concurring with the determination that the issuance of 7 IP leases by BOEMRE to allow the construction of up to 7 met towers and associated G&G surveys would not be likely to adversely affect any listed species under NMFS jurisdiction. BOEMRE reinitiated consultation with NMFS for the Garden State Offshore Energy/Deepwater Wind IP lease when developers opted to use a unique LIDAR equipped meteorological spar buoy. The developer determined it would be more cost efficient than construction of a meteorological tower. In a letter dated December 6, 2010, NMFS concluded that all the effects of the proposed action would be insignificant or discountable, and not likely to adversely affect any ESA-listed species under their jurisdiction.

U.S. Fish and Wildlife Service (FWS)

Informal ESA Section 7 consultations for "Non-Competitive Lease for Wind Resource Data Collection on the Northeast Outer Continental Shelf" were initiated with FWS on January 26, 2009. This consultation evaluated the issuance of several interim policy (IP) leases for wind resource data collection, including geological and geophysical (G&G) site assessment surveys. These IP leases were concentrated off of Delaware and New Jersey. The consultation was concluded in a letter from FWS dated February 26, 2009. The informal consultation concluded that the site assessment activities would not jeopardize the continued existence of the federally listed roseate tern (*Sterna dougallii dougallii*) and piping plover (*Charadrius melodius*), and the candidate species, red knot (*Calidris canutus rufa*). Although the extent to which these species occur 8+ miles offshore is not well known, the likelihood to which these species occur offshore was concluded to be low.

FWS further stated that the greater threat posed to avian species from site assessment activities, specifically the construction of meteorological towers, was the threat collisions between vessels and the structures and subsequent spilling of oil in the case of oil tankers. However, given the low number of proposed structures and the U.S. Coast Guard requirements for navigational aids, the risk was still considered to be low. In order to evaluate future collision risk assessment FWS recommended the placement of a visibility sensor, which measures transparency of the atmosphere by calculating a meteorological optical range, on the meteorological tower in addition to the biological monitoring devices already included.

3.0 Threatened and Endangered Species in the Proposed Action Area

The action area is defined as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action" (50 CFR §402.02). For this activity, the action area includes the Mid-Atlantic Wind Energy Areas (WEAs) (see Figure 1) as well as waters between the WEAs and shore. This area is expected to encompass all effects of the proposed actions. Several ESA-listed species occur seasonally in the action area. Since the proposed activities could occur year-round it can be assumed that these species could be present for all or some of the proposed activity. The Programmatic EIS for Alternative Energy Development and Production and Alternate Use of Facilities on the Outer Continental Shelf (MMS 2007b) gives greater detail of the life histories of the species outlined in this Section and is thus incorporated by reference and not repeated herein.

This Section also incorporates data gathered between January 2008 and December 2009 for the New Jersey Ocean/Wind Power Ecological Baseline Study (NJEP 2010). This study focused on the New Jersey WEA but has information that supports and is largely applicable to other areas in the mid-Atlantic. For marine mammals and sea turtles the survey consisted of aerial and shipboard surveys and well as passive acoustic monitoring. The aerial surveys took place monthly between February and May 2008 and twice monthly (when possible) between January and June 2009. The shipboard surveys occurred monthly between January 2008 and December 2009. Both followed predetermined tracklines and included opportunistic sightings when feasible. The acoustic monitoring consisted of six deployments of between 3 and 6 units placed in a cross or diamond configuration covering most of the action area. Avian abundance, distribution, and behavior were collected by shipboard surveys (offshore and coastal), aerial surveys, radar surveys (offshore and coastal), Next Generation Radar (NEXRAD), and Thermal Imaging-Vertically Pointing Radar (TI-VPR) studies, and supplemental surveys (shoal surveys and sea watch) were conducted over the 24-month period. No ESA-listed marine fish were identified in the action area during the study period.

3.1 Marine Mammals

Six cetaceans that may occur in the action area are federally listed as endangered (Table 1). The six whales species are the North Atlantic right whale, fin whale (*Balaenoptera physalus*), sei whale (*Balaenoptera borealis*), humpback whale (*Megaptera novaeangliae*), sperm whale (*Physeter macrocephalus*), and blue whale (*Balaenoptera musculus*). However, of these six species, only three – right, humpback, and fin whales – are likely to occur in the action area. Right and humpback whales are most likely to occur in the action area between November and April and fin whales are most likely to occur in the action area between October and January. However acoustic monitoring data indicates that individuals may occur through the WEAs throughout the year (NJDEP 2010). Although sperm and sei whales occur in the mid-Atlantic, sightings data indicate that these species are limited to areas further offshore beyond the activity area. Additionally, individual manatees are known to occasionally enter the mid-Atlantic region in the summer months, but a regular migration/occurrence has not been established and thus encounters with manatees would be highly unlikely. There is no critical habitat for marine mammals in the mid-Atlantic WEAs.

This information is supported by the results of the New Jersey study (NJDEP 2010) that found the following for right, humpback and fin whales (the only ESA-listed marine mammals observed in the study area) during shipboard and aerial surveys and passive acoustic monitoring (PAM data was not available for humpback whales):

Right Whales

Observed

Right whales were seen as single animals or in pairs (mean group size=1.5). Sightings occurred in water depths ranging from 17 to 26 m (56 to 85 ft) with a mean value of 22.5 m (73.8 ft). Distances from shore ranged from 19.9 to 31.9 km (10.7 to 17.2 NM) with a mean of 23.7 km (12.8 NM). Right whales were seen in winter, spring, and fall in waters with SST ranging from 5.5 to 12.2 degrees Celsius (°C; 41.9 to 54.0 degrees Fahrenheit [°F]; mean 10.0°C [50.0°F]). Three sightings were recorded during November, December, and January when right whales are known to be on the breeding/calving grounds farther south (Winn et al. 1986) or in the Gulf of Maine (Cole et al. 2009). The November 2008 sighting just south of the Study Area boundary was of an adult female who must have been migrating through the Study Area on her way to the calving grounds because she was sighted in mid-December 2008 off the coast of Florida (Zani, M., New England Aquarium, pers.comm., 14 January 2009). The sighting recorded in December 2009 near the southern boundary of the Study Area (water depth of 25 m/82 ft) was also of a female that was later sighted off the coast of Georgia in early January 2010 (Zani, M., New England Aquarium, pers. comm., 11 January 2010). Initially, two sightings of right whales were recorded close together in both time and space. Subsequent photo-identification analyses indicate that these sightings were of the same individual North Atlantic right whale. Therefore, the first sighting of this individual is considered the original sighting, and the second sighting is considered a re-sight of the individual. The January 2009 sighting was of two adult males; these whales were sighted offshore of Barnegat Light in the northernmost portion of the Study Area. The whales exhibited feeding behavior (i.e., surface skimming with mouths open) in 26 m (85 ft) of water; however, actual feeding could not be confirmed. During May 2008, a cow-calf pair was recorded in waters near the 17 m (56 ft) isobath southeast of Atlantic City. The pair was sighted in the southeast U.S. in January and February prior to the May sighting, and they were sighted in the Bay of Fundy in August (Zani, M., New England Aquarium, pers. comm., 6 January 2010).

Passive Acoustic Monitoring

Analysis of recordings captured in the Study Area during the baseline study period demonstrated North Atlantic right whale occurrence throughout the year, with a peak number of detection days in March through June (46 days in 2008, 10 in 2009 although June was not represented in 2009). North Atlantic right whales were also detected sporadically in the eastern and northern areas of the Study Area during the summer through the fall in 2008 (two days detected during July, five in August, five in September, one in October, six in November, and one in December) and in 2009 (three in August, six in September, four in October, and one in November). Nine days of detection (mid-January to mid-March 2009) resulted from the December 2008 PAM deployment even though only two of the five deployed pop-ups were recovered. During these winter months, the North Atlantic right whale calls were detected on the pop-up located 21.4 km (12 NM) from shore at a depth of 24 m (79 ft). Winter represents the time of year when North Atlantic right whale mothers and calves are found off the southeast U.S. coast (mainly off northern Florida and southern Georgia; Hamilton and Mayo 1990; Hain et al. 1992; Knowlton et al. 1992), but it is unknown where the majority of North Atlantic right whale males and females without calves spend their time during this season. Very little data are represented from the migratory corridor (i.e., the eastern U.S. coast from New Jersey to Virginia) between the southern calving grounds and the northern feeding grounds for comparison (Mead 1986; Knowlton et al. 1992; McLellan et al. 2002); however, these winter detection days are inconsistent with current distribution data.

Humpback Whales

Humpback whales are known to occur regularly throughout the year in the mid-Atlantic and may occur in the Study Area year-round. Seventeen sightings of humpback whales were recorded during the study period; seven of these were off-effort and 10 were on-effort. Humpback whales were sighted during all seasons; the majority of sightings (nine) were recorded during winter. Humpback whales were sighted as single animals or in pairs (mean group size=1.2). Distance from shore ranged from 4.8 to 33.2 km (2.6 to 18.0 NM; mean=18.4 km/9.9 NM). In mid-September 2008, a mixed species aggregation of a fin and humpback whale was recorded south of Atlantic City. The humpback whale was observed lunge feeding in the vicinity of the fin whale; the water depth of this sighting was 15 m (49 ft). Humpback whale sightings occurred at water depths ranging from 12 to 29 m (39 to 95 ft) with a mean depth of 20.5 m (67.3 ft). This species was sighted in waters with SST ranging from 4.7°C to 19.5°C (40.5 to 67.1°F; mean 10.1°C [50.2°F]). A cow-calf pair was recorded in February 2008 just north of the Study Area boundary in 20 m (66 ft) of water. This was the only sighting of a calf during the study period. Breaching behavior was observed during two sightings; the first was in May 2009 and the second was in October 2009. During the study period, photographs were taken whenever possible for photo-identification purposes. These photographs were compared to the College of the Atlantic's North Atlantic Humpback Whale Catalog. One individual sighted in the Study Area August 2009 was matched to the catalog and last observed in the Gulf of Maine in 2008 (Weinrich, M., Whale Center of New England, pers. comm., 11 January 2010).

Fin Whales

Observed

Fin whales were the most frequently sighted large whale species during the survey period. There were a total of 37 fin whale sightings; the majority of these (27) were recorded on effort. Fin whale group size ranged from one to four animals (mean group size=1.5). Water depth for fin whale sightings ranged from 12 to 29 m (39 to 95 ft) with a mean depth of 21.5 m (70.5 ft). SSTs for these sightings ranged from 4.2 to 19.7°C (39.6 to 67.5°F) with a mean temperature of 9.6°C (49.3°F). Fin whales were sighted between 3.1 and 33.9 km (1.7 and 18.3 NM) from shore with a mean distance of 20.0 km (10.8 NM).

Fin whales were sighted during all seasons. Twenty-six sightings were recorded throughout the Study Area during the 2008 surveys. Most of these sightings were recorded during the winter and summer. One mixed-species aggregation of a fin and humpback whale was observed in September. While the humpback whale was lunge feeding, the fin whale surfaced multi-directionally but did not appear to be feeding. One calf was observed with an adult fin whale in August 2008. During the 2009 surveys, fin whales were again the most frequently sighted baleen whale species and were seen in every season except summer for a total of 11 sightings. Attempts were made to photograph all the fin whales sighted during the surveys. These photographs were compared to the North Atlantic Finback Whale Catalogue managed by Allied Whale for possible matches but no matches have been made to date.

Passive Acoustic Monitoring

> The fin whale was the most common marine mammal species detected acoustically during PAM of the Study Area. Fin whale pulses were primarily documented in the northern and eastern range of the Study Area where the shelf waters were deeper (>25 m [82 ft]) and distance from shore was greater than 25 km (13 NM). The consistent presence of fin whale pulses indicates that this species, or at least members of this species, can be regularly found along the New Jersey outer continental shelf. Fin whale pulses and downsweeps were documented in every month of acoustic monitoring. The 20-hertz (Hz) infrasonic pulses have duration of ~1 s (Thomson and Richardson 1995; Charif et al. 2002). Automatic detection software facilitated an examination of all hard drives of data. Fin whales were detected on 47 days from March to May 2008, 62 days from June to September 2008, 31 days from October to December 2008, 57 days from January to March 2009, 16 days in April and May 2009, and 68 days from August to October 2009.

Sightings data for marine mammals has been compiled by the Nature Conservancy for their comprehensive Northwest Atlantic Marine Ecoregional Assessment (NAM ERA). The Nature Conservancy submitted maps of sightings data for marine mammals as part of their comments on BOEMRE's Notice of Intent to Prepare an Environmental Assessment (76 FR 7226, February 9, 2011) for this subject action. These comments are included in their entirety as Appendix 1. The underlying data sources for these maps include the NJ Baseline Study data and the U.S. Navy's Marine Resource Assessment data. Although one should read the entire comment to understand the limitations of this data set, especially in regards to the disparity in spatial scales between the data and the WEAs, the overall picture presented in Maps 2 and 4 of Appendix 1 is consistent with the predominantly winter (January – March) sightings for humpback and right whales (TNC 2011).

Table 1
Marine Mammals of the North Atlantic

Order, Suborder and Family of Cetacea	Common Name	Status
Suborder Mysticeti (baleen whales)		
Family Balaenidae		
Eubalaena glacialis	North Atlantic right whale	Endangered
Family Balaenopteridae		
Balaenoptera musculus	blue whale	Endangered
Balaenoptera physalus	fin whale	Endangered
Balaenoptera borealis	sei whale	Endangered
Balaenoptera edeni	bryde's whale	
Balaenoptera acutorostrata	minke whale	
Megaptera novaeangliae	humpback whale	Endangered

Table 1
Marine Mammals of the North Atlantic

Order, Suborder and Family of Cetacea	Common Name	Status
Suborder Odontoceti (toothed whales)		
Family Physeteridae		
Physeter macrocephalus	sperm whale	Endangered
Kogia breviceps	pygmy sperm whale	
Kogia simus	dwarf sperm whale	
Family Ziphiidae		
Hyperoodon ampullatus	northern bottlenose whale	
Mesoplodon densirostris	Blainville's beaked whale	
Mesoplodon europaeus	Gervais' beaked whale	
Mesoplodon mirus	True's beaked whale	
Ziphius cavirostris	cuvier's beaked whale	
Family Delphinidae		
Orcinus orca	killer whale	
Lagenorhynchus albirostris	white-beaked dolphin	
Feresa attenuate	pygmy killer whale	
Globicephala macrorhynchus	short-finned pilot whale	
Globicephala melas	long-finned pilot whale	
Grampus griseus	risso's dolphin	

Table 1
Marine Mammals of the North Atlantic

Order, Suborder and Family of Cetacea	Common Name	Status
Peponocephala electra	melon-headed whale	
Tursiops truncatus	Atlantic bottlenose dolphin	
Lagenorhynchus acutus	Atlantic white-sided dolphin	
Delphinus delphis	common dolphin	
Stenella coeruleoalba	striped dolphin	
Stenella attenuata	pantropical spotted dolphin	
Stenella clymene	clymene dolphin	
Stenella frontalis	Atlantic spotted dolphin	
Stenella longirostris	spinner dolphin	
Lagenodelphis hosei	fraser's dolphin	
Family Phocoenidae		
Phocoena phocoena	harbor porpoise	
Order Carnivora		
Suborder Pinnipedia		
Family Phocidae		
Phoca vitulina	harbor seal	
Halichoerus grypus	grey seal	
Pagophilus groenlandicus	harp seal	
Cystophora cristata	hooded seal	
Order Sirenia		

Table 1
Marine Mammals of the North Atlantic

Order, Suborder and Family of Cetacea	Common Name	Status
Family Trichechidae *Trichechus manatus*	West Indian manatee	Endangered

Source: Waring et al., 2007, 2006, 2002, and 1998

3.2 Sea Turtles

Of the six species of sea turtles that can be found in U.S. waters (Table 2), there are four endangered species that potentially utilize the proposed action area in the mid-Atlantic. These species include the loggerhead (*Caretta caretta*), green (*Chelonia mydas*), Kemp's ridley (*Lepidochelys kempii*), and leatherback (*Dermochelys coriacea*) sea turtles. These four species are all highly migratory, and no individual members of any of the species are likely to be year-round residents of the proposed action area. Individual animals will make migrations into nearshore waters as well as other areas of the North Atlantic Ocean, Gulf of Mexico, and the Caribbean Sea. There is no designated critical habitat for sea turtles in the mid-Atlantic.

Few researchers have reported on the density of sea turtles in Northeastern waters. However, this information is available from one source (Shoop and Kenney 1992). Shoop and Kenney (1992) used information from the University of Rhode Island's Cetacean and Turtle Assessment Program (CETAP[1]) as well as other available sightings information to estimate seasonal abundances of loggerhead and leatherback sea turtles in northeastern waters (CETAP 1982). The authors calculated overall ranges of abundance estimates for the summer of 7,000-10,000 loggerheads and 300-600 leatherbacks present in the action area from Nova Scotia to Cape Hatteras. Using the available sightings data (2841 loggerheads, 128 leatherbacks and 491 unidentified sea turtles), the authors calculated density estimates for loggerhead and leatherback sea turtles (reported as number of turtles per square kilometer). These calculations resulted in density estimates of 0.00164 – 0.510 loggerheads per square kilometer and 0.00209 – 0.0216 leatherbacks per square kilometer. It is important to note, however, that this estimate assumes that sea turtles are evenly distributed throughout the waters off the northeast, even though Shoop and Kenney report several concentration areas where loggerhead or leatherback abundance is much higher than in other areas. The Shoop and Kenney data, despite considering only the presence of loggerhead and leatherback sea turtles, likely overestimates the number of sea turtles present in the WEAs. This is due to the assumption that sea turtle abundance will be even throughout the Nova Scotia to Cape Hatteras action area, which is an invalid assumption. Sea turtles occur in high concentrations in several areas outside of the action area and the inclusion of these concentration areas in the density estimate skews the estimate for the action area.

[1] The CETAP survey consisted of three years of aerial and shipboard surveys conducted between 1978 and 1982 and provided the first comprehensive assessment of the sea turtle population between Nova Scotia, Canada and Cape Hatteras, North Carolina.

This information is supported by the results of the New Jersey study (NJDEP 2010) that found the following for leatherback and loggerhead sea turtles (the only ESA-listed sea turtles observed in the study area):

> **<u>Leatherback Sea Turtles</u>**
> Leatherback turtles are more common in mid-Atlantic waters during the summer and fall; however, this species may occur in the Study Area year-round. Twelve sightings of leatherback turtles were recorded during the surveys; nine of these were on-effort and three were off-effort. All leatherback turtle sightings were of single individuals; eight of the total 12 sightings were thought to be juveniles. Water depths of leatherback sightings ranged from 18 to 30 m (59 to 98 ft) with a mean depth of 24 m (79 ft). The SSTs associated with leatherback turtle sightings ranged from 18.1 to 20.3°C (64.6 to 68.5°F) with a mean of 19.0°C (66.2°F). This mean SST is the highest average value for any species or species group sighted during the survey period and is consistent with the seasonality of leatherback occurrence in the Study Area. Leatherback turtles were sighted only during the summer. The majority of sightings (seven) occurred in the far northern portion of the Study Area. Sightings were recorded from 10.3 to 36.2 km (5.6 to 19.5 NM) from shore with a mean distance of 28.6 km (15.4 NM).
>
> **<u>Loggerhead Sea Turtles</u>**
> Loggerhead turtles are more common in mid-Atlantic waters during the summer and fall; however, this species may occur in the Study Area year-round. A total of 69 sightings of loggerhead turtles were recorded during the surveys; the vast majority of these (63) were recorded on effort. The 15 unidentified hardshell turtle sightings recorded during spring and summer may have been loggerhead turtles; however, species identifications could not be confirmed. All loggerhead turtle sightings were of single individuals; four of the total 69 sightings were recorded as juveniles. Loggerhead sightings occurred in water depths ranging from 9 to 34 m (30 to 112 ft) with a mean depth of 23.5 m (77.1 ft). Distance from shore ranged from 1.5 to 38.4 km (0.8 to 20.7 NM; mean=24.6 km/13.3 NM). SSTs associated with these sightings ranged from 11.0 to 20.3°C (51.8 to 68.5°F) with a mean value of 18.5°C (65.3°F). This was the second highest mean SST of all sightings which is consistent with the strong seasonality of loggerhead occurrence in the Study Area. Loggerhead turtles were sighted from late spring through fall. The earliest a loggerhead was sighted was June and the latest was October. Sightings of loggerhead turtles are fairly evenly distributed although over 50% of the sightings were recorded in the eastern half of the Study Area. During the baseline study period, opportunistic sightings of sea turtles were recorded during monitoring efforts conducted in a potential windfarm site southeast of Atlantic City. Experienced observers recorded two juvenile loggerhead turtles during the geophysical surveys in August 2009 (GMI 2009b).

Sightings data for sea turtles has been compiled by the Nature Conservancy for their comprehensive Northwest Atlantic Marine Ecoregional Assessment (NAM ERA). The Nature Conservancy submitted maps of sightings data for sea turtles as part of their comments on BOEMRE's Notice of Intent to Prepare an Environmental Assessment (76 FR 7226, February 9, 2011) for this subject action. These comments are included in their entirety as Appendix 1. The underlying data sources for these maps include the NJ Baseline Study data and the U.S. Navy's Marine Resource Assessment data. Although one should read the entire comment to understand the limitations of this data set, especially in regards to the disparity in spatial scales between the data and the WEAs, the overall distribution presented in Map 1 of Appendix 1 is consistent with statements in this section.

Table 2

Sea Turtle Taxa of the Western North Atlantic

Order Testudines (turtles)	Relative Occurrence*	ESA Status**
Family Cheloniidae (hardshell sea turtles)		
Loggerhead sea turtle (*Caretta caretta*)	Common	Threatened
Green sea turtle (*Chelonia mydas*)	Uncommon	Threatened
Hawksbill sea turtle (*Eretmochelys imbricata*)	Rare	Endangered
Kemp's Ridley sea turtle (*Lepidochelys kempii*)	Common	Endangered
Family Dermochelyidae (leatherback sea turtle)		
Leatherback sea turtle (*Dermochelys coriacea*)	Uncommon	Endangered

*Population status in the western north Atlantic is summarized according to the following categories:

Common: A common species is one that is abundant wherever it occurs in the region (i.e., the western north Atlantic). Most common species are widely distributed over the area.

Uncommon: An uncommon species may or may not be widely distributed but does not occur in large numbers. Uncommon species are not necessarily rare or endangered.

Rare: A rare species is one that is present in such small numbers throughout the region that it is seldom seen. Although not threatened with extinction, a rare species may become endangered if conditions in its environment change.

**Endangered Species Act (ESA) status is summarized according to listing status under the following categories:

Endangered: Species determined to be in imminent danger of extinction throughout all of a significant portion of their range.

Threatened: Species determined likely to become endangered in the foreseeable future.

3.3 Marine Fish

Table 3 characterizes the major demersal finfish assembleges of the mid-Atlantic bight. Many of these species are of commercial importance but whose populations are not threatened or endangered. Species of concern include the shortnose sturgeon, which is federally-listed as endangered, and can be found off the coasts of New Jersey and Delaware. It is also possible that adult Atlantic salmon may occur off the coast while migrating to New England rivers to spawn; certain Gulf of Maine populations of Atlantic salmon are listed as endangered. Both the shortnose sturgeon and the Atlantic salmon are anadromous, meaning they spawn in rivers and spend their adult lives in the open ocean. The shortnose sturgeon is found in nearshore estuaries and rivers, including the Delaware River and Delaware Bay. Approximate age of females at first spawning is 11 years in the Hudson and Delaware Rivers. Females generally spawn every three years, although males may spawn every year. Threats to the species have included pollution, loss of access to spawning habitats and overfishing, both directly and incidentally. (NMFS 2010a)

Other fish species found in the mid-Atlantic include a Federal candidate species, the Atlantic sturgeon, and several Federal Species of Concern. The species of concern include 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.

The Atlantic sturgeon, another anadromous species, is found in the Hudson and Delaware Rivers. Tagging data indicates that immatures travel widely once they emigrate from natal rivers. The portion of the Delaware River and Bay that is available to Atlantic sturgeon extends from the mouth of Delaware Bay to the fall line at Trenton, NJ, a distance of 220.5 km (137 mi). There are no dams within this reach of the river. The freshwater tidal river, approximately 85.3 km (53 mi) in length from the Pennsylvania-Delaware border to Trenton, NJ, probably includes the primary spawning and nursery area for Atlantic sturgeon. At one time poor water quality may have adversely affected the use by fish of the upper tidal portion of the estuary, but in recent years water quality has improved.

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. 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).

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 3. 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 sculpin Winter flounder Yellowtail flounder Witch flounder Little skate Spiny dogfish	Black sea bass Summer flounder Butterfish Scup Spotted hake Northern searobin Smooth dogfish	Windowpane flounder	Fourspot flounder Cusk eel Gulf stream flounder	Shortnose greeneye Offshore hake Blackbelly rosefish White hake Witch flounder

3.4 Birds

The Atlantic coast is major flyway for birds this includes terrestrial species, shorebirds, waterbirds, and marine birds. The Roseate tern (*Sterna dougallii dougallii*) is federally listed as endangered and the Piping plover (*Charadrius melodius*) is federally listed as threatened. The red knot (*Calidris canutus rufa*) has been identified as a candidate for listing as threatened or endangered under ESA (USFWS, 2006a).

This Biological Assessment incorporates by reference Minerals Management Service Biological Assessment for the Cape Wind Energy Project in Nantucket Sound, which can be found at: http://www.mms.gov/offshore/PDFs/May2008CapeWindFinalBA.pdf (MMS, 2008b), as well as the U.S. Fish and Wildlife Service's Biological Opinion on the Wind Energy Project in Nantucket Sound, which can be found at:

http://www.fws.gov/northeast/newenglandfieldoffice/pdfs/CapeWind-BO-21November2008_withCovLttr.pdf (USFWS, 2008).

Table 4. Federally Endangered and Threatened Birds that may occur in the mid-Atlantic region of the OCS

Species	Federal Status	State
Piping plover (*Charadrius melodius*)	Threatened	VA, MD, DE, NJ
Roseate tern (*Sterna dougallii dougallii*)	Endangered	VA, NJ

Piping Plover
The piping plover is a shorebird that inhabits coastal sandy beaches and mudflats. This species is currently in decline and listed as endangered in the Great Lakes watershed (breeding range of the Great Lakes population of this species) and as threatened in the remainder of its range. It is listed as a result of historic hunting pressure, and loss and degradation of habitat (USFWS, 2006c). Critical wintering habitat has been established in each of the Gulf Coast States for all three populations (Atlantic, Great Lakes, and Great Plains) of the piping plover (66 FR 36038–36143).

According to the "New Jersey Offshore Wind Energy: Feasibility Study" (Atlantic Renewable Energy Corporation and AWS Scientific, Inc., 2004), this federally threatened and New Jersey endangered beach-nesting shorebird nests on New Jersey beaches from Sandy Hook to Cape May from April to October (arriving in late March). These birds feed entirely on the shore and are confined to the vicinity of their nests during that season. During the migration season, some individuals flying to nesting areas farther north along the coast undoubtedly fly along the New Jersey coast and may cross from Sandy Hook to Long Island. They undoubtedly cross from Cape Henlopen, Delaware, to Cape May or even farther north along the Jersey shore before they reach land. It is not known if any of these birds fly directly over water from Delaware to New York, thereby flying through New Jersey offshore waters. Little is known about their migration flight behavior.

Roseate Tern
The roseate tern is a seabird that commonly ventures into oceanic waters; however, its western Atlantic population is known to occur in the far southeastern Gulf to breed in scattered colonies along the Florida Keys (Saliva, 1993; USFWS 1999). It is currently listed as endangered for populations along the U.S. Atlantic Coast from Maine to North Carolina, Canada and Bermuda; it is listed as threatened in Florida, Puerto Rico, the Virgin Islands, and the remaining western hemisphere and adjacent oceans. It historically has ranged along the Atlantic tropical and temperate coasts south to North Carolina; in Newfoundland, Nova Scotia, and Quebec, Canada; and in Bermuda (USFWS, 2006c). No critical habitat has been designated for this species.

According to the "New Jersey Offshore Wind Energy: Feasibility Study" (Atlantic Renewable Energy Corporation and AWS Scientific, Inc., 2004) this species is listed as federally endangered because its population has declined dramatically and because these birds nest in a few, dense colonies making them potentially vulnerable to impacts (USFWS, 1989). No Roseate Terns are known to nest in New Jersey, although in the summer of 2003, several individuals frequented the tern colony at Stone Harbor Point for several weeks. In addition, several Roseate Terns frequented the tern colonies at the Rockaways and Breezy Point area of Long Island during June and July (New York City Parks and Recreation biologist, personal communication), only a few miles from the New Jersey offshore study area. Although the species used to nest on western Long Island's South Shore and in the 1920s and 1930s in southern New Jersey, they no longer do so. Roseate Terns are regular, although infrequent visitors to the Jersey Shore, mostly represented by a few individuals

Red Knot

Coastal habitats in the North Atlantic are considered critical to the survival of hemispheric populations of some shorebirds, such as red knots (Clark and Niles, 2000). According to the FWS's website (http://www.fws.gov/northeast/redknot/) the red knot is truly a master of long-distance aviation. On wingspans of 20 inches, red knots fly more than 9,300 miles from south to north every spring and repeat the trip in reverse every autumn, making this bird one of the longest-distance migrants in the animal kingdom. Surveys of knots wintering along the coasts of southern Chile and Argentina and along the Delaware Bay during spring migration indicate a serious population decline.

Red knots depend on the continued availability of billions of horseshoe crab eggs at major North Atlantic staging areas in the Delaware Bay and Cape May peninsula. The harvest of horseshoe crabs for bait in commercial fisheries that occurred in the 1990s may be a major factor in the decline in red knots. Red knots also rely on mid- and high-arctic habitat for breeding. Red knots could be particularly affected by global climate change, which may be greatest at the latitudes where this species breeds and winters.

3.5 Bats

Bat migration over the open water has been documented from August and October. Limited information exists on migration routes. Bat migration and associated migration corridors along the Atlantic coast are poorly understood.

The Indiana bat (*Myotis sodalist*) is a cave bat that is federally listed as endangered. . The species is located in the northern region of New Jersey with a population of 652 in 2005in a total of two hibernacula (USFWS 2007b). The number of hibernacula in Delaware is unknown. The species was originally listed as in danger of extinction under the Endangered Species Preservation Act of 1966, and is currently listed as endangered under the Endangered Species Act of 1973, as amended. The current Recovery Priority of the Indiana Bat is 8, which means that the species has a moderate degree of threat and high recovery potential. The eastern small-footed bat, also a cave bat, is a species of special concern.

During winter, Indiana bats are restricted to suitable underground hibernacula. The vast majority of these sites are caves located in karst areas (a landscape shaped by the dissolution of a layer or layers of soluble bedrock) of the east-central United States; however, Indiana bats also hibernate in other cave-like locations, including abandoned mines. In summer, most reproductive females occupy roost sites under the exfoliating bark of dead trees that retain large, thick slabs of peeling bark. Primary roosts usually receive direct sunlight for more than half the day. Roost trees are typically within canopy gaps in a forest, in a fenceline, or along a wooded edge. Habitats in which maternity roosts occur include riparian zones, bottomland and floodplain habitats, wooded wetlands, and upland communities. Indiana bats typically forage in semi-open to closed (open understory) forested habitats, forest edges, and riparian areas (interface between land and a stream) (USFWS 2007b). Since there are no island habitats in the proposed WEAs, it is unlikely that bat species would be foraging or migrating through the area. Therefore, the proposed actions are not likely to affect the Indiana bat and eastern small-footed bat. Additional information or a more detailed analysis and migration descriptions of bats can be found in the Cape Wind Energy Project DEIS (2008) and the Alternative Energy Programmatic EIS (2007).

4.0 Proposed Action

4.1 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

4.2 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, BOEMRE, in consultation with other Federal agencies and State Renewable Energy Task Forces, identified Wind Energy Areas (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. As a result of comments received on these notices and the NOI, the WEAs offshore New Jersey, Maryland, Delaware, and Virginia were further refined. The areas in which BOEMRE is proposing to begin the commercial lease issuance process and subsequent SAP approval process are as follows:

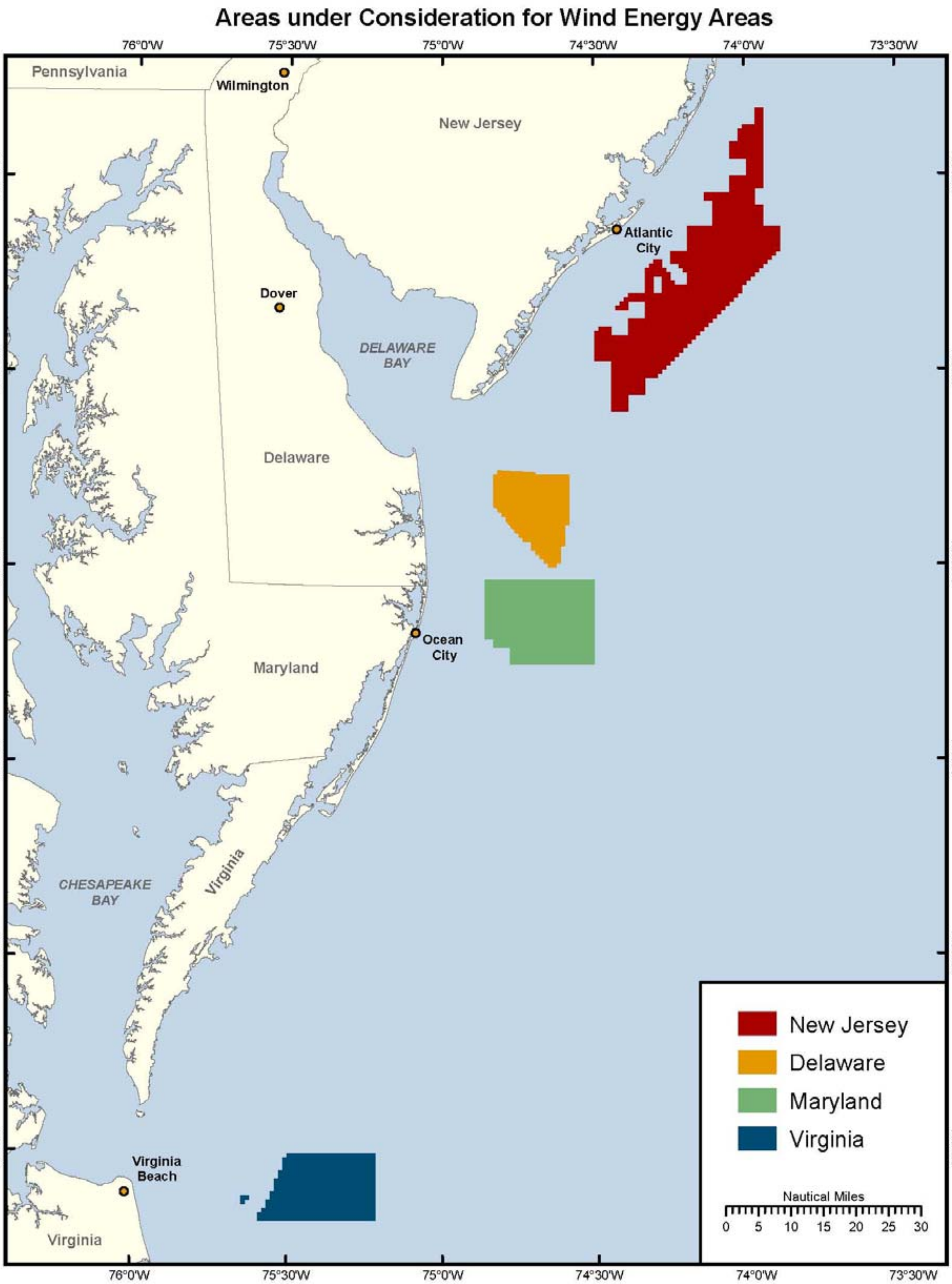
- *New Jersey*: The proposed area offshore New Jersey begins 7 nautical miles from the shore and extending roughly 23 nautical miles seaward (or the approximate 100 ft depth contour) and extends 72 nautical miles along the Federal/state boundary form Seaside Park south to Hereford Inlet. The entire area 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 Beach. The entire area is approximately 165 square nautical miles; 139,855 acres; or 56,597 hectares. Areas proposed by the State of Virginia for research activities within the scope of this assessment are included this scenario.

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 fewer 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

4.3 Site Characterization Surveys

Site characterization surveys include a variety of activities that assess of construction hazards and characterization of 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.

4.3.1 High-resolution Geophysical (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. 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.

4.3.1.1 HRG Survey Instrumentation

Table 5 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 5. 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 5 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 these isopleths numbers have 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.

4.3.1.2 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 6. Proposed Site Assessment Action Scenario

Wind Energy	High-resolution	Sub-bottom	Meteorological	Meteorological

Area (WEA)	Geophysical (HRG) Surveys (max miles/hours)	Sampling Locations (min-max)	Towers (max)	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

4.3.2 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.

4.3.3 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.

4.3.4 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).

4.3.4.1 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.

4.3.5 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. An environmental review will be performed for on individual SAPs 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.

4.3.5.1 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.

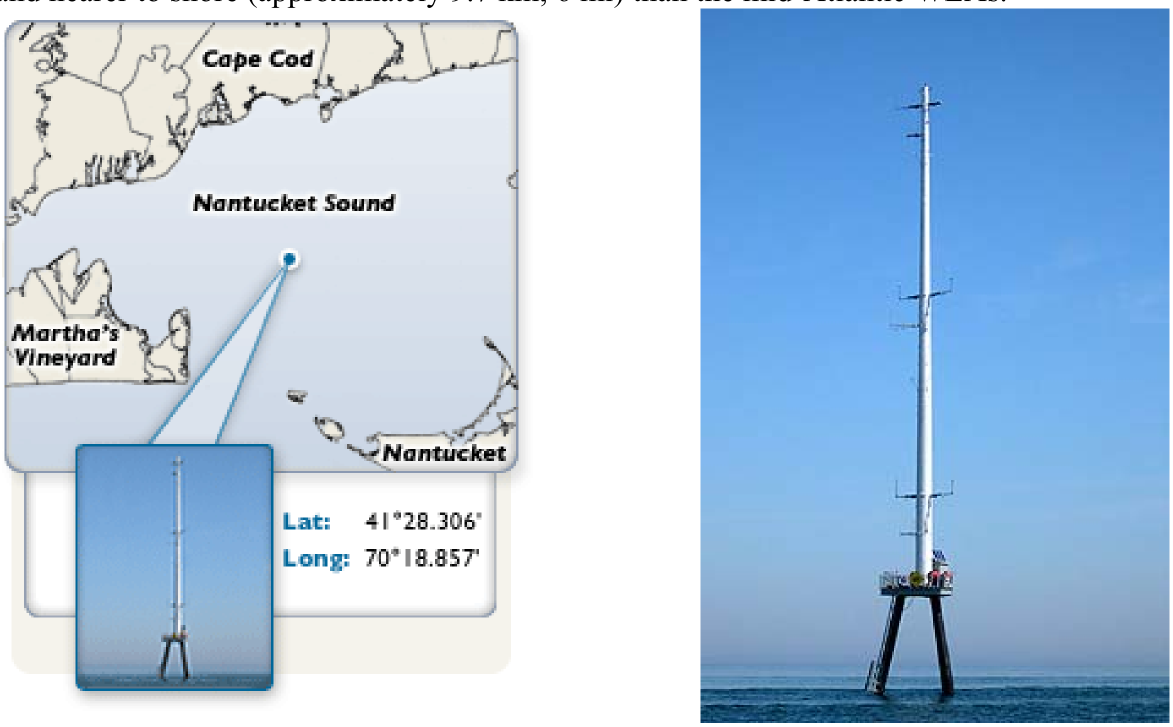


Figure 2. Cape Wind Meteorological Tower. Source: Cape Wind Associates, LLC.

4.3.5.2 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.

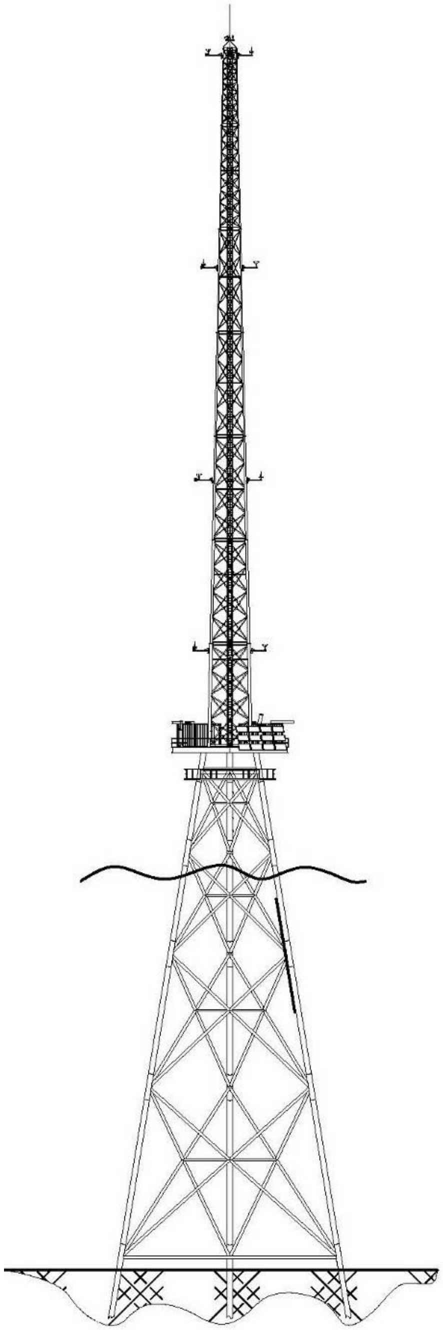


Figure 3. Example of a Lattice-type Mast Mounted on a Steel Jacket Foundation.
Source: Deepwater Wind, LLC.

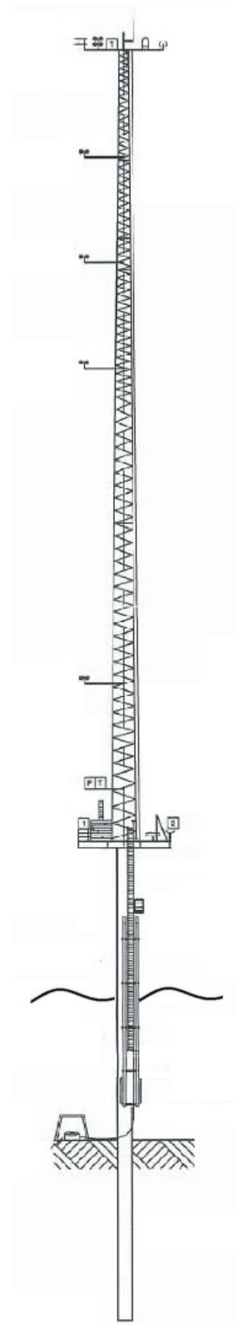


Figure 4. Example of a Lattice-type Mast Mounted on a Monopile Foundation.
Source: Fishermen's Energy of New Jersey, LLC.

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 7). 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 4.8.2, Removal of Scour Control System.

Figure 4. 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.

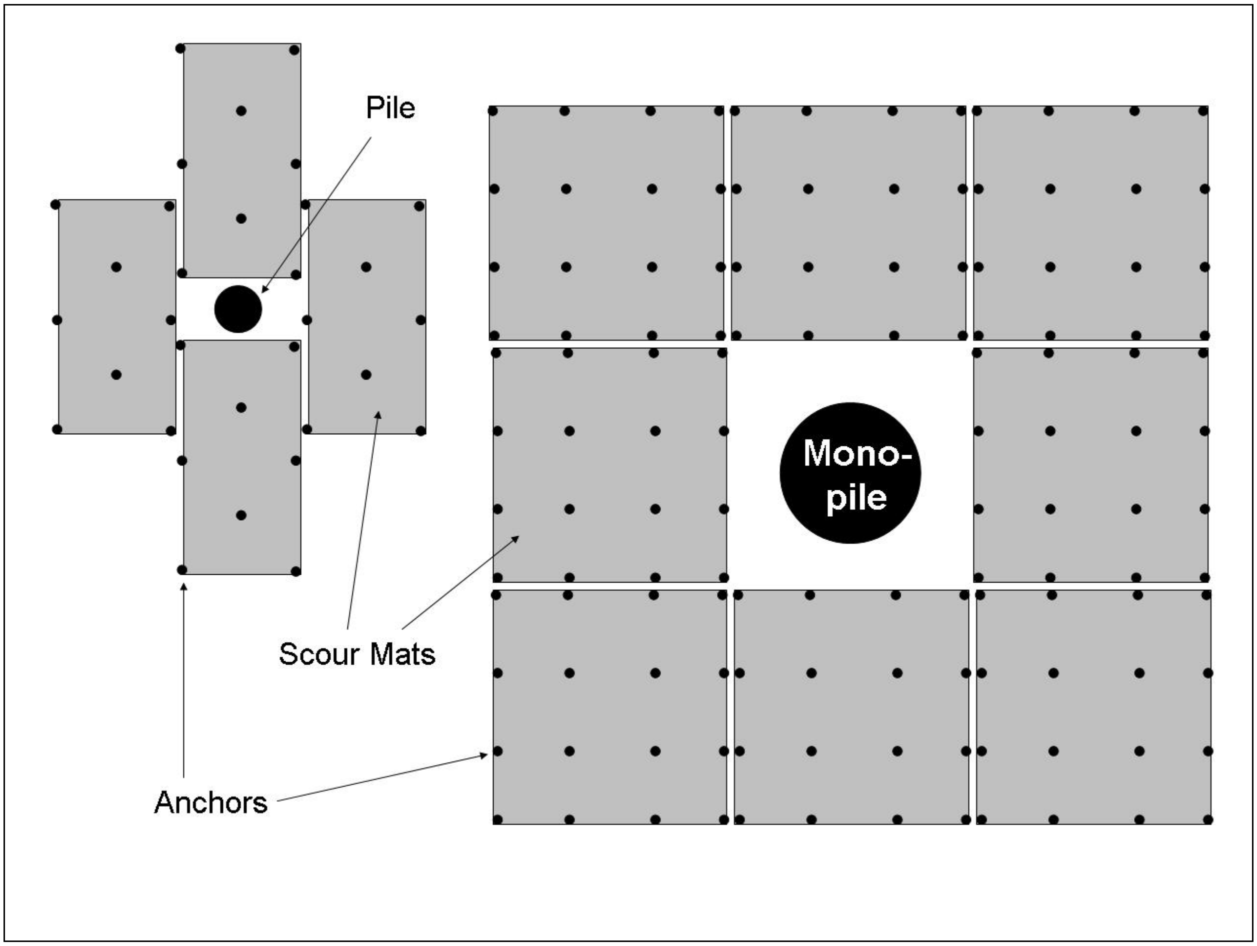


Figure 5. Examples of a scour control layouts.

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 5.

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 5 and 8.

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.

4.3.5.3 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.

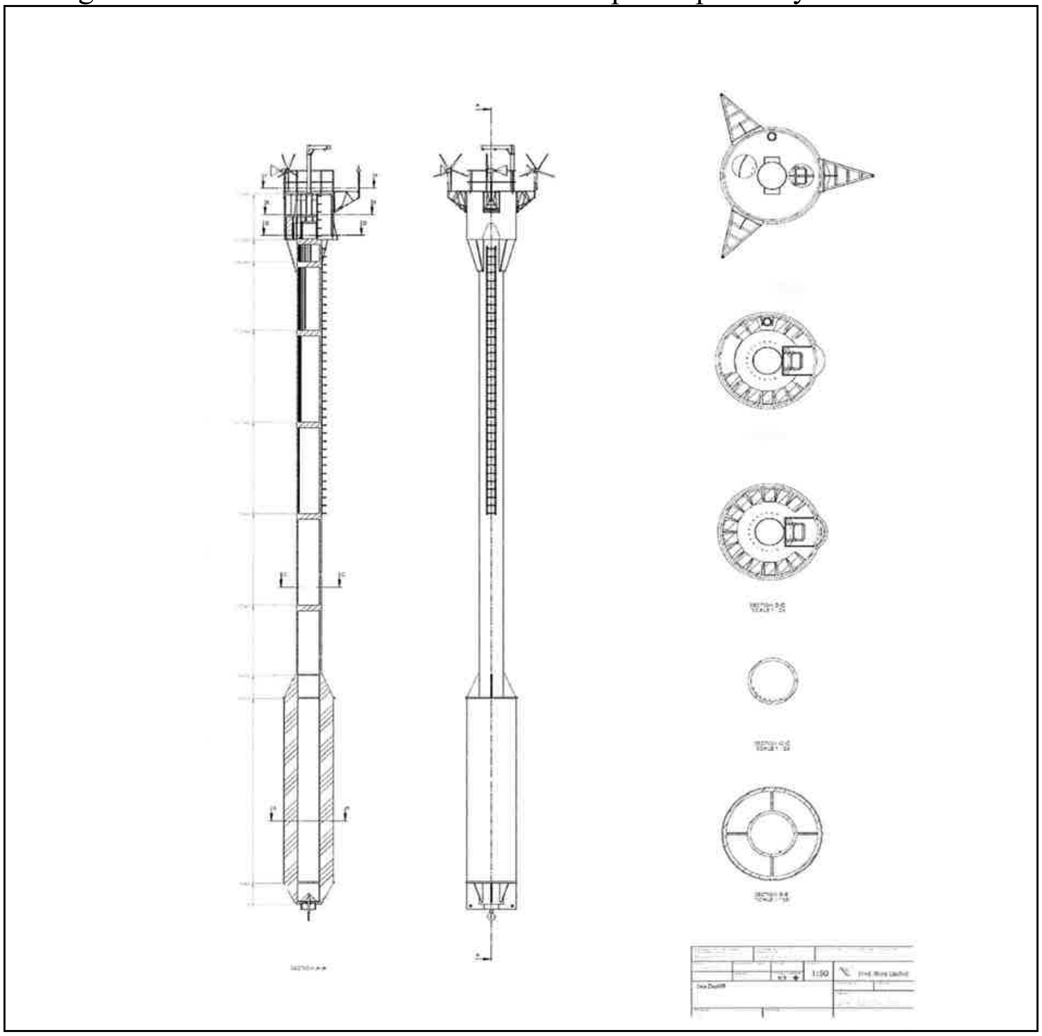
An analysis of the 100-year storm wind, tide, wave, and current characteristics and a structural analysis of the spar buoy design have been conducted to ensure that the Sea ZephIR™ can withstand the potential worst-case sea conditions at the site.

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.

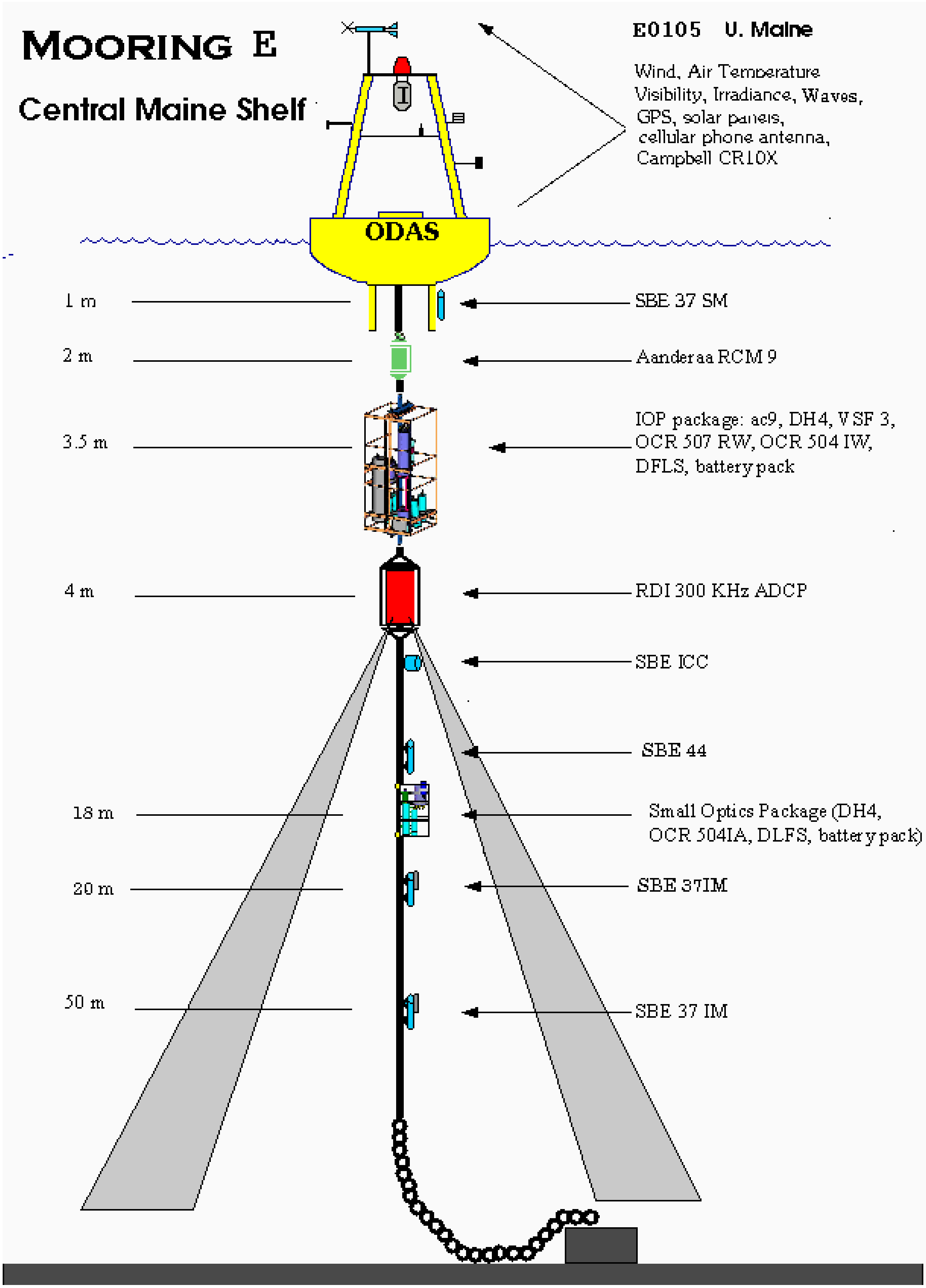


Figure 9. Example of an Ocean Monitoring Buoy. Source: Deepwater Wind, LLC.

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).

4.3.5.4 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.

4.4 Vessel Traffic

Vessel traffic, both by air and by sea, occurs during all phases of the site characterization and assessment activities. Due to concerns with collisions and potential pollution, vessel traffic for all phases of the site assessment are addressed in this section.

On December 9, 2008, in an effort to reduce ship strikes to endangered right whales, NOAA issued regulations requiring ships 65 feet (19.8 meters) or longer to travel at 10 knots or less in certain areas where right whales gather. The purpose of the regulations is to reduce the likelihood of deaths and serious injuries to endangered North Atlantic right whales that result from collisions with ships. This regulation also benefits other marine mammal species.

These new restrictions extend out to 20 nautical miles around major mid-Atlantic ports, which would include the mid-Atlantic WEAs. Except for crew boats, which are typically smaller than 65 feet, these restrictions would be applicable to most vessels associated with the proposed action. While most site assessment surveys, and construction and decommissioning activities would occur in late spring and summer, speed restrictions would be in effect from November 1st to April 30th. However there is a call for temporary voluntary speed limits at other times when a group of three or more right whales is confirmed. Wind energy developers would be required to abide by these otherwise voluntary restrictions (See Section 8.0).

HRG Survey Traffic
As detailed in Section 4.3.1.2, 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.

Vessels would be required to maintain a vigilant watch for marine mammals and sea turtles during transit to and from the survey area, as well as during the HRG survey itself. Section 8.0 details the monitoring and mitigation measures that would be required for vessels.

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 4.3.4.1, 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 7 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. 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). Avoidance of noise-sensitive areas, if practical, is preferable. Pilots operating noise producing aircraft over noise-sensitive areas should make every effort to fly not less than 2,000 feet above ground level, weather permitting. Departure from or arrival to an airport, climb after take-off, and descent for landing should 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, see Section 8.0 for monitoring and mitigation measures.

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 4.3.5.3, 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 7. 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

4.5 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.

4.6 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.

4.6.1 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.

4.6.2 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.

4.6.3 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.

4.6.4 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 North East 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.

5.0 Effects of the Proposed Action

The proposed action has 5 primary activities that will likely have environmental impact producing effects. 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 from these activities can be grouped into the following categories: (1) acoustic effects, (2) benthic habitat effects, (3) collision (vessel and tower) effects, (4) lighting effects, and (5) other effects.

5.1 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. Regardless, a brief description of the physical environment is included here. Section 3.0 gives a description of the species of concern that inhabit this area. The mid-Atlantic Wind Energy Areas are located in the mid-Atlantic Bight (MAB) of the Northeast Continental Shelf Large Marine Ecosystem. The following MAB characterization and tables 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). 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.

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.

Table 8. 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

5.2 Acoustic Effects

This Section on acoustic effects looks at what is known about noise sensitivity in marine fauna and the noise that could be produced as a result of site assessment activity in the mid-Atlantic WEAs.

5.2.1 Current Understanding of Noise Sensitivity in Marine Fauna

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, particularly marine mammals. 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.

Marine Mammals

Current thresholds established by NMFS for determining impacts to marine mammals typically center around root-mean-square (RMS) received levels of 180 dB re 1µPa for potential injury, 160 dB re 1µPa for behavioral disturbance/harassment from a non-continuous noise source, and 120 dB re 1µPa for behavioral disturbance/harassment from a continuous noise source. These thresholds are based on a limited number of experimental studies on captive odontocetes, a limited number of controlled field studies on wild marine mammals, observations of marine mammal behavior in the wild, and inferences from studies of hearing in terrestrial mammals. In addition, marine mammal responses to sound can be highly variable, depending on the individual hearing sensitivity of the animal, the behavioral or motivational state at the time of exposure, past exposure to the noise which may have caused habituation or sensitization, demographic factors, habitat characteristics, environmental factors that affect sound transmission, and non-acoustic characteristics of the sound source, such as whether it is stationary or moving (NRC 2003). Nonetheless, the threshold levels referred to above are considered conservative based on the best available scientific information at this time.

Right, Humpback, and Fin Whale Hearing

As discussed in Section 3.0, right, humpback and fin whales are the ESA-listed species likely to be affected by site assessment activity in the mid-Atlantic WEAs. Thus this section will primarily address those species. In order for right, humpback, and fin whales to be adversely affected by project related noise, they must be able to perceive the noises produced by the activities. If a species cannot hear a sound, or hears it poorly, then the sound is unlikely to have a significant effect (Ketten 1998). Baleen whale hearing has not been studied directly, and there are no specific data on sensitivity, frequency or intensity discrimination, or localization (Richardson et al. 1995) for these whales. Thus, predictions about probable impact on baleen whales are based on assumptions about their hearing rather than actual studies of their hearing (Richardson et al. 1995; Ketten 1998).

Ketten (1998) summarized that the vocalizations of most animals are tightly linked to their peak hearing sensitivity. Hence, it is generally assumed that baleen whales hear in the same range as their typical vocalizations, even though there are no direct data from hearing tests on any baleen whale. Most baleen whale sounds are concentrated at frequencies less than 1 kHz (Richardson et al. 1995), although humpback whales can produce songs up to 8 kHz (Payne and Payne 1985). Based on indirect evidence, at least some baleen whales are quite sensitive to frequencies below 1 kHz but can hear sounds up to a considerably higher but unknown frequency. Most of the manmade sounds that elicited reactions by baleen whales were at frequencies below 1 kHz (Richardson et al. 1995). Some or all baleen whales may hear infrasounds, sounds at frequencies well below those detectable by humans. Functional models indicate that the functional hearing of baleen whales extends to 20 Hz, with an upper range of 30 Hz. Even if the range of sensitive hearing does not extend below 20-50 Hz, whales may hear strong infrasounds at considerably lower frequencies. Based on work with other marine mammals, if hearing sensitivity is good at 50 Hz, strong infrasounds at 5 Hz might be detected (Richardson et al. 1995). Fin whales are predicted to hear at frequencies as low as 10-15 Hz. The right whale uses tonal signals in the frequency range from roughly 20 to 1000 Hz, with broadband source levels ranging from 137 to 162 dB (RMS) re 1 μPa at 1 m (Parks & Tyack 2005). One of the more common sounds made by right whales is the "up call," a frequency-modulated upsweep in the 50–200 Hz range (Mellinger 2004). The following table summarizes the range of sounds produced by right, humpback, and fin whales (from Au et al. 2000):

Table 9. Summary of known right, humpback, and fin whale vocalizations

Species	Signal type	Frequency Limits (Hz)	Dominant Frequencies (Hz)	Source Level (dB re 1μPa RMS)	References
North Atlantic Right	Moans	< 400	--	--	Watkins and Schevill (1972)
	Tonal	20-1000	100-2500	137-162	Parks and Tyack (2005)
	Gunshots		50-2000	174-192	Parks et al. (2005)
Humpback	Grunts	25-1900	25-1900	--	Thompson, Cummings, and Ha (1986)
	Pulses	25-89	25-80	176	Thompson, Cummings, and Ha (1986)
	Songs	30-8000	120-4000	144-174	Payne and Payne (1985)
Fin	FM moans	14-118	20	160-186	Watkins (1981), Edds (1988), Cummings and Thompson (1994)
	Tonal	34-150	34-150		Edds (1988)
	Songs	17-25	17-25	186	Watkins (1981)

Most species also have the ability to hear beyond their region of best sensitivity. This broader range of hearing probably is related to their need to detect other important environmental phenomena, such as the locations of predators or prey. Considerable variation exists among marine mammals in hearing sensitivity and absolute hearing range (Richardson et al. 1995; Ketten 1998); however, from what is known of right, humpback, and fin whale hearing and the source levels and the volume and frequencies of the met tower construction noise sources (see Section 4.3.5.2), it is evident that if present in the area where the underwater noise occurs, right, humpback, and fin whales are capable of perceiving construction related noises, and have hearing ranges that are likely to have peak sensitivities in low frequency ranges that overlap the dominant frequencies of pile driving and vessel noise.

Sea Turtles

The hearing capabilities of sea turtles are poorly known. Few experimental data exist, and since sea turtles do not vocalize, inferences cannot be made from their vocalizations as is the case with baleen whales. Direct hearing measurements have been made in only a few species. An early experiment measured cochlear potential in three Pacific green turtles and suggested a best hearing sensitivity in air of 300–500 Hz and an effective hearing range of 60–1,000 Hz (Ridgway et al. 1969). Sea turtle underwater hearing is believed to be about 10 dB less sensitive than their in-air hearing (Lenhardt 1994). Lenhardt et al. (1994) used a behavioral "acoustic startle response" to measure the underwater hearing sensitivity of a juvenile Kemp's ridley and a juvenile loggerhead turtle to a 430-Hz tone. Their results suggest that those species have a hearing sensitivity at a frequency similar to those of the green turtles studied by Ridgway et al. (1969). Lenhardt (1994) was also able to induce startle responses in loggerhead turtles to low frequency (20–80 Hz) sounds projected into their tank. He suggested that sea turtles have a range of best hearing from 100–800 Hz, an upper limit of about 2,000 Hz, and serviceable hearing abilities below 80 Hz. More recently, the hearing abilities of loggerhead sea turtles were measured using auditory evoked potentials in 35 juvenile animals caught in tributaries of Chesapeake Bay (Bartol et al. 1999). Those experiments suggest that the effective hearing range of the loggerhead sea turtle is 250–750 Hz and that its most sensitive hearing is at 250 Hz. In general, however, these experiments indicate that sea turtles generally hear best at low frequencies and that the upper frequency limit of their hearing is likely about 1 kHz. As such, sea turtles are capable of hearing in low frequency ranges that overlap with the dominant frequencies of pile driving and vessel noise, therefore, if exposed to construction-related noise these species may be affected by this exposure.

Marine Fish

The auditory thresholds of ESA-listed marine fish and species of concern that could occur in the mid-Atlantic WEAs (see Section 3.3) 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.

Avifauna

Loud noises including pile driving and construction noise can disturb nesting birds. However, the activity of constructing met towers on the Atlantic OCS is far from nesting roseate tern colonies and piping plovers on the coast. Thus, noise from these activities will have no impact on nesting roseate terns and piping plovers. Sound attenuates much more quickly in air than it does in water, given that and the fact that acoustic energy from met tower construction is directed downward through the water column, the acoustic effects to birds and bats is considered negligible.

5.2.2 High Resolution Geologic Survey Acoustic Effects

High resolution geologic 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 4.3.1, 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 4.3 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 4.3.1.

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 4. 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 whales, sea turtles, and most fish that may occur in the action area. As noted in Table 3, 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.

Marine Mammals

ESA-listed marine mammals are expected to migrate through the mid-Atlantic WEAs between October – April (Section 3.1). Taking into account the mitigation measures that are planned (Section 8), effects on cetacean behavior are generally expected to be limited to avoidance of the area around the HRG survey activities and short-term changes in behavior, falling within the MMPA definition of "Level B harassment." Cetaceans are highly mobile and likley to quickly leave an area when disturbing noise levels are present. While an HRG survey may disturb more than one individual, routine surveys are not expected to result in population-level effects. Individuals disturbed by HRG survey noise would likely return to normal behavioral patterns after the survey has ceased (or after the animal has left the survey area).

There is wide distribution of whales in the proposed mid-Atlantic WEAs as they migrate north and south to their summer and winter feeding grounds, respectively. Although whales may be present in a wind energy area during an HRG survey, the likely maximum ranges of the 180 dB and 160 dB isopleths, (estimated at maximum of 30 meters and 400 meters, respectively) make it unlikely that any whales would be exposed to injurious or disturbing sound levels associated with the survey. The risk of exposure is further reduced by BOEMRE's required use of an observer which will ensure that the survey equipment is not operated if a whale or sea turtle is within 500 meters of the survey vessel

Because of the mobility of the sound source during HRG surveys, and the likelihood that marine mammals would leave the immediate vicinity of the surveys, few individuals may be expected, in most cases, to be present within the survey areas. Thus, potential population-level impacts on marine mammals from HRG surveys are expected to be negligible.

Sea Turtles

If the surveys occur between June and November, listed sea turtles could be exposed to noise effects of the HRG survey. BOEMRE would require that the applicants maintain a 500 meter exclusion zone during the survey and that this exclusion zone be monitored for at least 30 minutes prior to ramp up of the survey equipment. The normal duration of sea turtle dives ranges from 5-40 minutes depending on species, with a maximum duration of 45-66 minutes depending on species (Spotila 2004). As sea turtles typically surface at least every 60 minutes, it is reasonable to expect that monitoring the exclusion zone for at least 30 minutes prior to ramp up and continuing through to full operation will allow the endangered species monitors to detect any sea turtles that may be submerged in the exclusion zone.

The survey vessel will not likely travel at speeds greater than 4.5 knots while surveying. The observer will continually monitor the 500 meter exclusion zone and the equipment will be shut down if a sea turtle is observed within the exclusion zone. As the survey vessel travels along the transects it is expected that any sea turtles in the area that are close enough to perceive the sound will swim away from it. As noted in Section 5.2.2, potentially disturbing levels of noise (i.e., greater than 160 dB) will be experienced only within approximately 400 meters of the survey equipment.

In order for a sea turtle to be exposed to injurious levels of noise, the sea turtle would need to be within 27 meters of the survey equipment. Given the noise levels produced by the survey equipment and given the expected behavioral response of avoiding noise levels greater than 160 dB, it is extremely unlikely that any sea turtles would swim towards the survey vessel. As such, it is extremely unlikely that any sea turtles would be exposed to injurious levels of noise.

Sea turtles whose behavior is disrupted would likely be expected to resume their behavior after the disturbance has stopped. While the surveys would likely use the full daylight hours available to them, approximately 10 hours per day, the time that any particular area will experience elevated sound levels will be significantly shorter. Available information indicates that sea turtle forage items are available throughout the action area; therefore, while sea turtles may move to other areas within the action area to forage during the times when the survey is occurring, the ability of individual sea turtles to find suitable forage is not expected to be impacted. Likewise, if sea turtles were resting in a particular area they are expected to be able to find an alternate resting area within the action area. Additionally, if sea turtles are migrating through the action area, they may avoid the area with disturbing levels of sound and choose an alternate route through the action area. While the movements of individual sea turtles will be affected by the sound associated with the survey, these effects will be temporary and localized. Sea turtles are not expected to be excluded from large areas and there will be only a minimal impact on foraging, migrating or resting sea turtles that will not result in injury or impairment in an individual's ability to complete essential behavioral functions. Major shifts in habitat use or distribution or foraging success are not expected. As changes to individuals movements are expected to be minor and short-term, and are therefore not likely to have population-level effects.

Marine Fish

The impact of HRG survey noise on ESA-listed marine fish and species of concern that could occur in the mid-Atlantic WEAs is not well understood. ESA listed marine fish, shortnose sturgeon and Atlantic salmon, are mainly coastal, and the majority of the WEAs are not within their preferred habitat. HRG survey work will be conducted along potential electric cable pathways from the lease blocks to shore, but this area is much more limited than the actual WEA lease blocks. 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, as for marine mammals and turtles, 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 location 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. Furthermore, ESA-listed marine fish, shortnose sturgeon and Atlantic salmon, are more likely to occur along cable route surveys, rather than surveys occurring within the lease blocks. Therefore, it is unlikely that either species would be within the impact area. Therefore, impacts, such as temporary or permanent hearing damage and masking, of such surveys to ESA-listed fish, and fish in general, would be negligible.

Avifauna

Roseate terns and piping plovers are unlikely to be on the OCS during HRG surveys, therefore no impacts are anticipated.

5.2.3 Sub-bottom Reconnaisssance 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 aquired from vibracores and CPTs and require obtaining a geologic profile via a borehole. Acoustic impacts from borehole drilling are expected to be below the 120 dB threshold established by NMFS for marine mammal harassment from a continuous noise source. 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.

Since drilling is considered by NMFS to be a continuous noise source, the level of noise considered harassment under the MMPA is 120 dB. As a result, BOEMRE will require a 200m exclusion zone for marine mammals and sea turtles during deep hole boring activity. It is generally expected that the activity of setting up drilling equipment will deter marine mammals, sea turtles, and fish from entering the work area. There would be nothing that would prevent animals from leaving or avoiding areas where drilling would take place. Other sub-bottom reconnaissance activity, such as the use of a CPT, is expected to only have minor acoustic impacts, primarily from vessel engines. As no whales or sea turtles will occur within 150m of any geotechnical drilling, no whales or sea turtles will be exposed to sound levels greater than 120 dB.

5.2.4 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 8.0 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 (i.e., NMFS threshold for behavioral disturbance/harassment from a non-continuous noise source) 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 10 below.

Table 10. Modeled areas of ensonification from pile driving.

Project (modeled)	Additional Info	180 dB re 1μPa (rms)	160 dB re 1μPa (rms)
Bluewater Wind (IP Lease Delaware)	3.05m diameter monopole; 900kJ hammer	760m	7,230m
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 8.0 for details**	**1,000m**	**7,000m**

Behavioral disturbance/harassment of whales may occur when individuals are exposed to pulsed noise levels (i.e., non-continuous noise sources such as those generated by an impact pile driver that will be used for monopole installation) greater than 160 dB re 1 μPa. In order to minimize the effects of pile driving on listed species, BOEMRE will require developers to implement several mitigation measures as a part of their lease. These measures are detailed Section 8. These measures include a "soft start" procedure and the requirement that no pile driving occur if any whales or sea turtles are present within 7 km of the pile to be driven. Outside the 7 km exclusion zone, noise levels are anticipated to be below 160dB re 1 μPa.

Marine Mammals

During meteorological tower construction, marine mammals in the vicinity of the construction site may be disturbed by noise generated during pile driving. Such noise could disturb normal behaviors (e.g., feeding, social interactions), mask calls from conspecifics, disrupt echolocation capabilities, and mask sounds generated by predators. Behavioral effects may be incurred at ranges of many miles, and hearing impairment may occur at close range (Madsen et al. 2006). Behavioral reactions may include avoidance of, or flight from, the sound source and its immediate surroundings, disruption of feeding behavior, interruption of vocal activity, and modification of vocal patterns (Watkins and Scheville 1975; Malme et al. 1984; Bowles et al. 1994; Mate et al. 1994). Depending on the frequency of the noise generated during construction of the meteorological towers, impacts to marine mammals may also include temporary hearing loss or auditory masking (Madsen et al. 2006). The biological importance of hearing loss or behavioral responses to construction noise (e.g., effects on energetics, survival, reproduction, population status) is unknown, and there is little information regarding short-term or long-term effects of behavioral reactions on marine mammal populations. While noise generated during construction of a meteorological tower may affect more than one individual, population-level effects are not anticipated. Some species may be expected to quickly leave the area with the arrival of construction vessels, before pile-driving activities are begun, while individuals remaining in the area may flee with the initiation of construction, thereby greatly reducing their exposure to maximal sound levels and, to a lesser extent, masking frequencies. Individuals disturbed by or experiencing masking due to construction noise would likely return to normal behavioral patterns after the construction had ceased (pile driving for each met tower installation is anticipated to be completed within a 3-day period), or after the animal has left the survey area.

Injury of marine species that could be caused by the pile driving noise are expected only in the immediate vicinity of the pile driving activity at distances of the order of 100 meters, and behavioral effects at ranges of the order of 10 kilometers or more. However, construction of a meteorological tower would be of relatively short duration and limited to a maximum of 10 locations throughout the mid-Atlantic WEAs (see met tower/buoy action scenario in Section 4). The monitoring and mitigations set forth in Section 8 of this BA reduce the chance of injury and harassment. Because marine mammals would be expected to leave the immediate vicinity of the tower during its construction, impacts to marine mammals in general would be of limited duration.

In the unlikely event that a whale is present within the APE when the monopoles are being installed, no pile driving would occur if any marine mammal is within 7 km of the pile. As exposure to harassing levels of sound (i.e., 160dB re 1uPa) is likely to only occur within 7 km of the pile being driven, and no pile driving will occur if a whale were within 7 km of the pile, no whales will be exposed to sound levels greater than 160 dB and no whales will be exposed to sound levels at which injury could occur (i.e., 160dB re 1µPa). If future field-verified acoustic data indicates the 160 dB isopleth is greater than 7 km, then future mitigation measures in lease stipulations would be modified to reflect the new data if similar conditions warrant the change. In the case where more than one monopole is being installed per met tower (e.g. tripod structure), then field verifications could modify the mitigation measures for the installation of additional monopoles (see Section 8.0).

Although the potential for construction-related sounds to cause injury to whales and sea turtles is extremely low, the analysis below considers the potential for whales and sea turtles to be exposed to disturbing levels of sound produced by these activities. For pile driving, potentially harassing levels of sound (180 - 160 dB) is expected to propagate over a distance of no more than 7.3km from the source.

Large whales present within the WEAs are generally expected to be in transit to summer feeding grounds in the Gulf of Maine/Bay of Fundy region or to their winter calving grounds in the U.S. South Atlantic and Caribbean Sea. However, as NJ baseline study acoustic data indicates, this movement could occur throughout the year. The location of these whales can be monitored and pile driving could be delayed until any whales leave the area. Based on the best available information and the mitigation measures in Section 8.0, no right, humpback or fin whales are expected to be exposed to noise levels greater than 160 dB. As such, no whales will be exposed to noise levels resulting in behavioral disturbance or harassment.

Sea Turtles

Since leatherback, green, Kemp's ridley and loggerhead sea turtles are known to occur in the mid-Atlantic between June and October and construction may occur during this time period, these species may be exposed to construction-related noise during the construction period without appropriate mitigation measures. Noise from pile driving could disturb normal behaviors (e.g., feeding) and cause affected individuals to move away from the construction area. The biological importance of behavioral responses to construction noise (e.g., effects on energetics, survival, reproduction, population status) is unknown, and there is little information regarding short-term or long-term effects of behavioral reactions on sea turtle populations. While noise generated during construction of a meteorological tower may affect more than one individual, population-level effects are not anticipated. Few individuals are expected to be exposed to construction noise, given the short-term duration of construction activities, geographic area affected, lack of presence in these areas during portions of the year, and the addition of monitoring and mitigation measures (as discussed in Section 8).

There is very little information about sea turtle behavioral reactions to levels of sound below the thresholds suspected to cause injury or TTS. However, some studies have demonstrated that sea turtles have fairly limited capacity to detect sound, although all results are based on a limited number of individuals and must be interpreted cautiously. Ridgway et al. (1969) found that one green turtle with a region of best sensitivity around 400 Hz had a hearing threshold of about 126 dB in water. Streeter (in press) found similar results in a captive green sea turtle, which demonstrated a hearing threshold of approximately 125 dB at 400 Hz, but better sensitivity at 200 Hz (110-115 dB threshold). McCauley (2000) noted that dB levels of 166 dB re 1μPa were required before any behavioral reaction was observed.

The available information on sea turtle behavioral responses to these sound levels indicates that individuals are likely to actively avoid areas with disturbing levels of sound. Avoidance behavior may shorten the exposure period; however, the avoidance behavior could potentially disrupt normal behaviors. Reactions of individual sea turtles to the pile driving is expected to be limited to an avoidance response. Only pile driving occurring during the June – November time frame has the potential to affect sea turtles, as sea turtles are not expected to occur in the action area outside of this time of year.

Sea turtles behaviorally disrupted would be expected to resume their behavior after the pile driving has stopped. As pile driving will occur for approximately 4-8 hours a day, it is likely that sea turtles will be excluded from the area with disturbing levels of sound for at least this period each day. Available information indicates that sea turtle forage items are available throughout the action area; therefore, while sea turtles may move to other areas within the action area to forage during the times when pile driving is occurring, the ability of individual sea turtles to find suitable forage is not expected to be impacted. Likewise, if sea turtles were resting in a particular area they are expected to be able to find an alternate resting area within the action area.

Additionally, if sea turtles are migrating through the action area, they may avoid the area with disturbing levels of sound and choose an alternate route to avoid the sound source. As such, while the movements of individual sea turtles while be affected by the sound associated with the pile driving, these effects will be temporary and localized. It is expected that there will be only a minimal impact on foraging, migrating or resting sea turtles that will not result in injury or impairment in an individual's ability to complete essential behavioral functions. Major shifts in habitat use or distribution or foraging success are not expected.

As explained above, the 7 km exclusion zone will be monitored by a trained endangered species observer for at least 30 minutes. It is expected that the observer will be able to detect the presence of any sea turtle at the surface within the 7 km exclusion zone. The normal duration of sea turtle dives ranges from 5-40 minutes depending on species, with a maximum duration of 45-66 minutes depending on species (Spotila 2004). It is reasonable to expect that monitoring the exclusion zone for at least 30 minutes will allow the endangered species monitor to detect any sea turtles that may be within the exclusion zone. Sound levels will have dissipated to below the 160 dB threshold within a distance of 7 km. As no pile driving will occur if a sea turtle is within 7km of the pile, no sea turtles are likely to be exposed to potentially injurious or harassing levels of sound. Thus, sea turtles are not likely to be exposed to levels of construction-related noise that will result in injury or harassment. Changes to individuals movements are expected to be minor and short-term, and are therefore not likely to have population-level effects.

Marine Fish

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.

However, the ESA-listed marine fish that are present in the mid-Atlantic, shortnose sturgeon and Atlantic salmon, are mainly coastal which is outside the proposed action area. Therefore, it is unlikely that either ESA-listed marine fish species would be taken within the impact area. Therefore, construction noise impacts, such as temporary or permanent hearing damage and masking, would not be expected for ESA-listed marine fish.

Avifauna

Loud noises including pile driving and construction noise can disturb nesting birds. However, the activity of constructing met towers on the Atlantic OCS is far from nesting bird colonies of on the coast. Thus, noise from these activities will have no impact on nesting roseate terns and piping plovers.

5.2.5 Vessel Traffic Noise

Marine mammals may also be affected by the noise generated by surface vessels traveling to and from construction sites. Exposure of marine mammals to individual construction vessels would be transient, and the noise intensity would vary depending upon the source and specific location. Reactions of marine mammals may include apparent indifference, cessation of vocalizations or feeding activity, and evasive behavior (e.g., turns, diving) to avoid approaching vessels (Richardson et al. 1995; Nowacek and Wells 2001). Behavior would likely return to normal following passage of the vessel, and it is unlikely that such short-term effects would result in long-term population-level impacts for most species of marine mammals. Thus, impacts from vessel noise would be short-term.

Marine mammals may also be disturbed as a result of over-flights of helicopters supporting offshore construction activities (but will not be used during operations and maintenance). Individuals beneath or near the flight paths may be startled by the presence of noise of the passing helicopter, ceasing normal behaviors and diving or fleeing the immediate area to avoid the oncoming helicopter (see Richardson et al. 1995 and Withrow et al. 1985), but may be expected to return after the helicopter has left the area. Large groups of humpbacks have been observed to show little to no response to small aircraft, while groups containing only adults showed some avoidance (Richardson et al. 1995). Fin whales have been observed to react slightly to small aircraft circling at altitudes of about 160 to 980 ft (50 to 300 m) above the surface. Helicopter traffic is probably more disruptive, but few data are available on the effects of helicopter over-flights on these or other species. Cetaceans disturbed by helicopter over-flights may be expected to cease their normal behaviors until the noise source has passed.

5.3 Benthic Effects

Benthic effects from the proposed action that will impact ESA-listed species is anticipated to be negligible due to the species utilization of the benthic environment and the limited impact to the benthos itself. Although there is no critical habitat within the mid-Atlantic WEAs, the habitats of ESA-listed marine mammals, sea turtles, and marine fish would the benthic environment. Examples of benthic forage items for ESA-listed species include sand lance, in the case of cetaceans and fish; and seagrass, macroalgae, and benthic invertebrates, in the case of sea turtles.

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 4.3.4.1). 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 ESA-listed marine mammals, sea turtles, and 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 ESA-listed 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 ESA-listed 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). Fishes 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.

5.4 Collision Effects

This section addresses direct impacts from the collision of an ESA-listed species with structures and vessels described in the proposed action. A collision with marine life, such as a whale, could result in injury to the animal and/or damage to the facility. However, since these are fixed platforms, BOEMRE anticipates that marine life will avoid colliding with the structures.

Safety fairways, traffic separation schemes, and anchorages are the most effective means of preventing vessel collisions with OCS structures. None of the mid-Atlantic WEAs overlap with exiting traffic separation schemes, thus a met tower or met buoy would not be permitted within these areas. As mentioned elsewhere in this document all met towers and buoys are required to have sufficient navigational lighting as well as filing a notice to mariners of their location.

Vessels associated with site assessment surveys, or construction, maintenance or decommissioning of the meteorological tower could collide with marine mammals, turtles, and other marine animals during transit. To limit or prevent such collisions, NMFS provides all boat operators with “Whale-watching Guidelines,” which is derived from the MMPA. These guidelines suggest safe navigational practices based on speed and distance limitations when encountering marine mammals. The frequency of vessel collisions with marine mammals, turtles, or other marine animals probably varies as a function of spatial and temporal distribution patterns of the living resources, the pathways of maritime traffic (coastal traffic is more predictable than offshore traffic), and as a function of vessel speed, the number of vessel trips, and the navigational visibility. Further discussion of direct collision impacts to ESA-listed species is below. Collision impacts are not expected with ESA-listed marine fish.

Marine Mammals
Vessel traffic bringing equipment and personnel to meteorological tower construction sites may affect marine mammals either by direct collisions with vessels or by disturbances from either vessels or helicopters. At least 11 species of cetaceans have been documented to have been hit by ships in the world’s oceans, and in most cases the whales were not seen beforehand or were seen too late to avoid collision (Laist et al. 2001; Jensen and Silber 2004). Whale strikes have been reported at vessel speeds ranging from 2 to 51 knots (2 to 59 mph), with most lethal or severe injuries occurring at ship speeds of 14 knots (16 mph) or more (Laist et al. 2001; Jensen and

Silber 2004). Whale strikes have occurred with a wide variety of vessel types, including Navy vessels, container and cargo ships, freighters, cruise ships, and ferries (Jensen and Silber 2004), and collisions with vessels greater than 80 m (260 ft) in length are usually either lethal or result in severe injuries (Laist et al. 2001).

Ship strikes have been recorded in U.S. waters in almost every coastal State. Collisions between whales and vessels have been most commonly reported along the Atlantic Coast, followed by the Pacific Coast (including Alaska and Hawaii); ship-whale collisions have been least common in the Gulf of Mexico (Jensen and Silber 2004). In addition, most ship strikes seem to occur over or near the continental shelf (Laist et al. 2001). The most frequently struck species has been the fin whale, followed by humpback, North Atlantic right, gray, minke, southern right, and sperm whales (Jensen and Silber 2004). The North Atlantic right whale has six major congregation areas from Florida to Maine, the humpback and fin whale congregate at feeding grounds in the North Atlantic. Thus, among these species, the North Atlantic right whale, the humpback whale and fin whale may be considered most likely to encounter vessels supporting the construction of meteorological towers in mid-Atlantic Wind Energy Areas.

It should be noted that vessels conducting activity under their lease are subject to regulations requiring ships 19.8 m (65 ft) or longer to travel at 10 knots (11.5 mph) or less in certain areas where right whales gather. The purpose of the regulations is to reduce the likelihood of deaths and serious injuries to endangered North Atlantic right whales that result from collisions with ships. This regulation also benefits other marine mammal species. These restrictions extend out to 37 km (20 nm) around major mid-Atlantic ports. Except for crew boats, which are typically smaller than 19.8 m (65 ft), these restrictions would be applicable to most vessels associated with the proposed action. In addition to the mandatory speed restrictions in these Seasonal Management Areas (SMAs) vessels would also be required to check with NOAA's Sighting Advisory System when Dynamic Management Areas (DMAs) are in place. The full compliance guide can be found at: http://www.nmfs.noaa.gov/pr/pdfs/shipstrike/compliance_guide.pdf

Considering the mitigation measures in place, it is expected that significant impacts would be unlikely due to the limited intermittent activities spread out temporally, as well as geographically in the mid-Atlantic WEAs.

Sea Turtles

Sea turtles have been killed or injured by collisions with vessels. Because of their limited swimming abilities, hatchlings may be more susceptible than juveniles or adults to vessel collisions. The likelihood of collision would vary depending upon species and life stage, the location of the vessel, and its speed and visibility. Hatchling turtles would be difficult to spot from a moving vessel because of their small size and generally cryptic coloration patterns. While adult and juvenile turtles are generally difficult to observe at the surface during periods of daylight and clear visibility, they are very difficult to spot from a moving vessel when they are resting below the water surface, and during night and periods of inclement weather.

While the towed gear (i.e., the boomer and/or chirper) has the potential to result in interaction with sea turtles, the speed of towing (typically about 3 knots) minimizes the potential for entanglement or vessel strikes during the survey as sea turtles would be able to avoid the slow moving gear and survey vessel. Because of the small amount and short duration of vessel traffic that would be associated with meteorological tower construction, population-level impacts to sea turtles from vessel collisions are not expected.

Avifauna

Birds colliding with the meteorological towers maybe injured or killed. However such events are rare and due to the small number of meteorological towers proposed will be distant from shore where roseate terns and piping plover nest, thus the impact due to collisions during nesting season would be negligible. Piping plovers on the Atlantic coast mostly migrate along the coast but do cross open water to winter in the Bahamas. Given the small number of meteorological towers proposed, the chance of collision for piping plover and roseate tern are likely to be very small and the impact would be negligible.

5.5 Lighting Effects

Lighting has a major role in attracting or disorientating night flying birds towards communication towers during foggy or and rainy conditions. However, communication towers with FAA-approved flashing red or white obstruction lights had significantly fewer avian fatalities than towers with steady burning lights (Gehring et al 2009).

5.6 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.

Marine Mammals

Marine mammals 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 marine mammals.

Ingestion of, or entanglement with, solid debris can adversely impact marine mammals. Mammals 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 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 marine mammals 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 each 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 marine mammals from the discharge of waste materials or the accidental release of fuels are expected to be minor.

Sea Turtles

During meteorological tower construction, a variety of sanitary and other waste fluids, and miscellaneous trash and debris, may be generated. Hatchling, juvenile, and adult sea turtles may be exposed to these wastes by discharges from the construction vessels. 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 shipboard waste treatment facilities before being discharged overboard. Deck drainage would also be processed prior to discharge.

Ingestion of plastic and other non-biodegradable debris has been reported for almost all sea turtle species and life stages (NOAA 2003). Ingestion of waste debris has resulted in gut strangulation, reduced nutrient uptake, and increased absorbance of various chemicals in plastics and other debris (NOAA 2003). Sub-lethal quantities of ingested plastic debris can result in various effects including positive buoyancy, making sea turtles more susceptible to collisions with vessels, increasing predation risk or reducing feeding efficiency (Lutcavage et al. 1997). Some species of adult sea turtles, such as loggerheads, appear to readily ingest plastic debris that is appropriately sized. In oceanic waters, floating or subsurface translucent plastic material and sheeting may be mistaken for gelatinous prey items such as jellyfish. Entanglement in debris (such as rope) can result in reduced mobility, drowning, and constriction of and subsequent damage to limbs (Lutcavage et al. 1997).

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]). Assuming compliance with these regulations and laws and only accidental releases, very little exposure of sea turtles to solid debris generated during meteorological tower construction would be anticipated.

Marine Fish

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.

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 from the discharge of waste materials or the accidental release of fuels are expected to be minor.

Birds

Marine and coastal birds could be exposed to operational discharges or accidental fuel releases from construction sites and construction vessels and to accidentally released solid debris. Gulls and other species often follow ships to forage on fish and other prey injured or disoriented in the vessel's wake. In doing so, these birds may be affected by discharges of waste fluids (such as bilge water) generated by the vessels. 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, impacts to marine and coastal birds from waste discharges from construction vessels are expected to be negligible. Marine and coastal birds may become entangled in or ingest floating, submerged, and beached debris (Heneman and the Center for Environmental Education 1988; Ryan 1987, 1990).

Entanglement may result in strangulation, the injury or loss of limbs, entrapment, or the prevention or hindrance of the ability to fly or swim, and all of these effects may be considered lethal. Ingestion of debris may irritate, block, or perforate the digestive tract, suppress appetite, impair digestion of food, reduce growth, or release toxic chemicals (Dickerman and Goelet 1987; Ryan 1988; Derraik 2002).

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 marine and coastal birds is not expected, and impacts to marine and coastal birds would be negligible. 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 wastes, debris, hazardous materials, or fuels would occur infrequently and cease following completion of the geological and geophysical surveys, meteorological tower construction, and meteorological tower decommissioning. The likelihood of an accidental fuel release would also be limited to the active construction and decommissioning periods of the site characterization.

In addition to these reasons discussed above, the footprint of the meteorological towers within the birds' habitat is expected to be small. Therefore, the effect on birds is expected to be short term and will have a negligible result in harassment. The mitigation and monitoring measures proposed in Chapter 4 will minimize or eliminate the potential for effects. Therefore, the proposed actions are likely to affect but not adversely affect ESA-listed or non-ESA-listed birds.

5.7 Meteorological Tower and Buoy Decommissioning

The decommissioning of met towers and buoys is described in Section 4.6. This Section primarily addresses the decommissioning of a met tower, as it is more extensive than that of a met buoy in that it involves more than just the potential impacts of vessel trips, which are assessed separately in Section 5.4. Decommissioning activity is not expected to have any impacts to ESA-listed birds or bats.

Marine Mammals

Upon completion of site assessment activities, the meteorological tower would be removed and transported by barge to shore. During this activity, marine mammals 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. Marine mammals 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 marine mammals during decommissioning is expected to be minor.

Sea Turtles

Upon completion of site characterization, the meteorological tower would be removed and transported by barge to shore. During this activity, sea turtles may be affected in the same manner as described for meteorological tower construction. Removal of the mooring 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, and sea turtles in the immediate vicinity could be disturbed by noise during the cutting of the pilings. Affected animals may be expected to move away from the immediate vicinity of the site.

Marine Fish

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.

6.0 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.

7.0 Conclusions

The following are the conclusions of BOEMRE regarding the anticipated impacts of site assessment activities described herein for the mid-Atlantic WEAs to ESA-listed marine mammals, marine fish, and birds. There is no critical habitat for any ESA-listed species in the mid-Atlantic WEAs.

Conclusions –Marine Mammals

The proposed actions and subsequent effects to ESA-listed marine mammals, specifically North Atlantic right, humpback, and fin whales, are expected to be short term and will result in minimal to negligible harassment depending on the specific activity. The activity and impacts are considered minimal due to activity itself in some cases, and the spatial-temporal setting in which the proposed activity will take place. Specifically, harassment from noise and slight increases in the risk of vessel collisions are the primary anticipated impacts to marine mammals. In order to minimize these impacts BOEMRE has developed conservative mitigation and monitoring measures detailed in Section 8.0. After a review of the proposed activities and the required mitigation measures, BOEMRE concludes that proposed actions are likely to affect but not adversely affect ESA-listed marine mammals.

Conclusion- Sea Turtles

The proposed actions and subsequent effects to ESA-listed sea turtles, specifically leatherback, Kemp's ridley, green, and loggerhead sea turtles, are expected to be short term and will result in minimal to negligible harassment depending on the specific activity. The activity and impacts are considered minimal due to activity itself in some cases, and the spatial-temporal setting in which the proposed activity will take place. Specifically, harassment from noise, minor loss/displacement from forage areas, and to a lesser degree vessel collisions, are the primary anticipated impacts to ESA-listed sea turtles. In order to minimize these impacts BOEMRE has developed conservative mitigation and monitoring measures detailed in Section 8.0. After a review of the proposed activities and the required mitigation measures, BOEMRE concludes that proposed actions are likely to affect, but not adversely affect, ESA-listed sea turtles.

Conclusion – Marine Fish

The proposed action is not anticipated to impact any ESA-listed marine fish as the action area has little to no overlap with the ESA-listed species ranges adjacent to the action area - primarily shortnose sturgeon and Atlantic salmon. As a result, BOEMRE concludes that the proposed action will not adversely affect ESA-listed marine fish.

Conclusion – Avifauna

The proposed action is not anticipated to impact the ESA-listed piping plover and roseate tern as the action area has no overlap with both species' nesting and foraging areas. Do to the small number of structures and the restricted time period of exposure, BOEMRE concludes that the proposed action will not adversely affect ESA-listed piping plover or roseate tern.

8.0 MITIGATION, MONITORING AND REPORTING REQUIREMENTS FOR ESA LISTED SPECIES

This section outlines the specific mitigation, monitoring and reporting measures built into the proposed action to minimize or eliminate potential impacts to ESA-listed species of whales, sea turtles, fish and birds. Additional mitigation, monitoring or reporting measures may be included in any issued BOEMRE lease or other authorization, including those that may be developed during the Federal ESA Section 7 consultation process.

8.1. 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.

8.1.1 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.

8.1.2. Requirements During Pre-Construction Site Assessment Surveys

Section 4 of this BA 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.

8.1.3 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 5.0 of this BA 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

- *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 (impulse). An infrared range finder may be used to determine distance from the pile to the reference location.
- *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.

8.2 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.

8.2.1 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.

8.3 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.

8.4 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, durations, and spectral characteristics of the impact and vibratory pile driving sounds; and the peak, rms, and energy levels of the sound pulses and their durations as a function of distance, water depth, and tidal cycle.

8.5 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.

9.0 References

Alling, A.K. and R. Payne. 1991. In: Leatherwood, S. (ed.). Song of the Indian Ocean blue whale, *Balaenoptera musculus.* Special issue on the Indian Ocean Sanctuary.

American Cetacean Society (ACS). 2007. ACS Cetacean Fact Sheets. Online at http://www.acsonline.org/factpack/.

Aroyan, J. L., M. A. McDonald, S. C. Webb, J. A. Hildebrand, D. Clark, J. T. Laitman, and J. S. Reidenberg. 2000. Acoustic Models of Sound Production and Propagation, Pages 409-469 *in* W. W. L. Au, A. N. Popper, and R. R. Fay, eds. Hearing by Whales and Dolphins. New York, Springer-Verlag.

Atlantic Renewable Energy Corporation and AWS Scientific, Inc. 2004. New Jersey offshore wind energy: feasibility study. Final Version. December 2004. Prepared for NJ Board of Public Utilities. Accessible at http://www.njcleanenergy.com/files/file/FinalNewJersey.pdf.

Au, W. W. L., A. N. Popper, and R. R. Fay. 2000. Hearing by Whales and Dolphins, Pages 485. New York, Springer-Verlag.

Beardsley, R.C., A.W. Epstein, C. Chen, K.F. Wishner, M.C. Macaulay, and R.D. Jebbet. 1996. Spacial variability in zooplankton abundance near feeding right whales in the Great South Channel. Deep-Sea Research 43(7-8):1601-1625.

Barco, S.G., W.A. McLellan, J.M. Allen, R.A. Asmutis-Silva, R. Mallon-Day, E.M. Meagher, D. A. Pabst, J. Robbins. R.E. Seton, W.M. Swingle, M.T. Weinrich, and P.J. Clapham. 2002. Population identity of humpback whales (*Megaptera novaeangliae*) in the waters of the U.S. mid-Atlantic states. J. Cetacean Res. Manage. 4(2): 135-141.

Bartol, S.M., and J.A. Musick. 2003. Sensory biology of sea turtles, pp. 79-102. *In:* P.L. Lutz, J.A. Musick, and J. Wyneken (eds.), The Biology of Sea Turtles, Volume II. CRC Press, Boca Raton, FL. 455 pp.

Bartol, S.M., J.A. Musick, and M. Lenhardt. 1999. Auditory evoked potentials of the loggerhead sea turtle (*Caretta caretta*). Copeia 99(3):836-840.

Baumgartner, M.F., T.V.N. Cole, P.J. Clapham, and B.R. Mate. 2003. North Atlantic right whale habitat in the lower Bay of Fundy and on the SW Scotian Shelf during 1999-2001. Marine Ecology Progress Series 264:137-154.

Békésy, G. 1948. Vibration of the head in a sound field, and its role in hearing by bone conduction. J. Acoust. Soc. Am. 20:749-760.

Bolten, A.B. 2003. Active Swimmers – Passive Drifters: The oceanic juvenile stage of loggerheads in the Atlantic system Pages 63-78 *in* Bolten and Witherington, 2003.

Bowles A.E., M. Smultea, B. Würsig, D.P. DeMaster, and D. Palka. 1994. “Relative Abundance and Behavior of Marine Mammals Exposed to Transmissions from the Heard Island Feasibility Test,” *Journal of the Acoustical Society of America* 96(4):2469–2484.

Broward County Biological Resources Division (Broward County BRD). 2007. Broward County Manatee Protection Plan. Online at http://www.co.broward.fl.us//bio/manatees_mpp.htm.

Carlson, T.J., G. Ploskey, R.L. Johnson, R.P. Mueller, M.A. Weiland, P.N. Johnson. 2001. Observations of the behavior and distribution of fish in relation to the Columbia River navigation channel and channel maintenance activities. Richland, WA. Prepared for the U.S. Army, Corps of Engineers, Portland District by Pacific Northwest National Laboratory, U.S. Department of Energy. 35 p. + appendices. Available at http://www.osti.gov/bridge/product.biblio.jsp?osti_id=787964&queryId=4&start=0.

Casper, B.M., P.S. Lobel and H.Y. Yan. 2003. The hearing sensitivity of the little skate, *Raja erinacea*: A comparison of two methods. Envir. Biol. Fish. 68:371-379.

CETAP. 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf. Cetacean and Turtle Assessment Program (CETAP), University of Rhode Island. Final Report, Contract #AA51-CT8-48. Bureau of Land Management, Washington, DC.

Charif, R. A., D. K. Mellinger, K. J. Dunsmore, K. M. Fristrup, and C. W. Clark. 2002. Estimated source levels of fin whale (*Balaenoptera physalus*) vocalizations: Adjustments for surface interference. Marine Mammal Science 18:81-98.

Christensen, I., T. Haug, and N. Oien. 1992. A review of feeding and reproduction in large baleen whales (*Mysticeti*) and sperm whales (*Physeter macrocephalus*) in Norwegian and adjacent waters. Fauna Norvegica Series A 13:39-48.

Clapham, P.J. 2000. The humpback whale: Seasonal feeding and breeding in a baleen whale. Pages 173-196 in Mann, J., R.C. Connor, P.L. Tyack, and H. Whitehead, eds. Cetacean societies: Field studies of dolphins and whales. Chicago, Illinois: University of Chicago Press.

Clapham, P.J. and J.G. Mead. 1999. *Megaptera novaeangeliae*. Mammalian Species 604:1-9.

Clapham, P.J., L. Baraff, C. Carlson, M. Christian, D.K. Mattila, C. Mayo, M. Murphey, and S. Pittman. 1993. Seasonal occurrence and annual return of humpback whales in the southern Gulf of Maine. Can. J. Zool. 71:440-443.

Clark, C.W.1982. The acoustic repetoire of the southern right whale, a quantitative analysis. Animal Behavior 30:1060-1071.

Clark, C.W. and K. Fristrup. 1997. Whales '95: A combined visual and acoustic survey of blue and fin whales off southern California. Rep. Int. Whal. Commn. 47:583-600.

Clark, C.W. and. P.J. Clapham. 2004. Acoustic monitoring on a humpback whale (*Megaptera novaeangliae*) feeding ground shows continual singing into late spring. Proc. R. Soc. Lond. B. 271: 1051-1057.

Clark, C.W. and R. Charif. 1998. Monitoring the occurrence of large whales off north and west Scotland using passive acoustic arrays. Society of Petroleum Engineers (SPE). SPE/UKOOA European Environmental Conference, Aberdeen, Scotland, April 1997.

Clark, C.W. and W.T. Ellison. 2004. Potential use of low-frequency sounds by baleen whales for probing the environment: evidence from models and empirical measurements. Pp. 564-582 *in*: Echolocation in bats, and dolphins. J. Thomas, C. Moss, and M. Vater, eds. The University Press of Chicago.

Clark, K.E. and L.J. Niles. 2000. North Atlantic Regional Shorebird Plan, Version 1, U.S. Shorebird Conservation Plan, Division of Migratory Bird Management, U.S. Fish and Wildlife Service, Arlington, VA.

Clark, L.S., D.F. Cowan, G.A.J. Worthy, and E.M. Haubold. 2002. An anatomical and pathological examination of the first recorded stranding of a Fraser's dolphin (*Lagenodelphis hosei*) in the northwestern Gulf of Mexico. Gulf of Mexico Science 20(1): 38-43.

Clarke, M. R. 1976. Observations on Sperm Whale Diving. Journal of the Marine Biological Association of the United Kingdom 56:809-810.

Continental Shelf Associates, Inc., 2004, *Geological and Geophysical Exploration for Mineral Resources on the Gulf of Mexico Outer Continental Shelf, Final Programmatic Environmental Assessment,* OCS EIS/EA, BOEMRE 2004-054, prepared by Continental Shelf Associates, Jupiter, FL, for the U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA, July. Available at: http://www.gomr.mms.gov/PDFs/2004/2004-054.pdf.

Coffin, A., Kelley, M., Manley, G.A., and Popper, A.N. 2004. Evolution of sensory hair cells. In: *Evolution of the Vertebrate Auditory System* (eds. G.A. Manley, A.N. Popper, and R.R. Fay). Springer-Verlag, New York, 55-94.

Coombs, S. and A.N. Popper. 1979. Hearing differences among Hawaiian squirrelfishes (Family Holocentridae) related to differences in the peripheral auditory anatomy. J. Comp. Physiol. 132:203-207.
Coombs, S. and J.C. Montgomery. 1999. The enigmatic lateral line system. In: Fay, R. R. and A.N. Popper (eds.). Comparative hearing: fish and amphibians. Springer-Verlag, NY. pp. 319-362.

Coombs, S., J. Janssen, and J. Montgomery. 1992. Functional and evolutionary implications of peripheral diversity in lateral line systems. In: Webster, D.B., R.R. Fay, and A.N. Popper (eds.). Evolutionary biology of hearing.

Coombs, S., P. Görner, and H. Münz (eds.). 1989. The mechanosensory lateral line: neurobiology and evolution. Springer-Verlag, NY.

Colvocoresses, J.A.; Musick, J.A. 1984. Species associations and community composition of Middle Atlantic Bight continental shelf demersal fishes. *Fish.Bull. (Wash. D.C.)* 82:295-313.

Croll, D.A., B.R. Tershy, A. Acevedo, and P. Levin. 1999. Marine vertebrates and low frequency sound. Technical Report for LFA EIS. Marine Mammal and Seabird Ecology Group, Institute of Marine Sciences, University of California, Santa Cruz.

Croll, D. A., A. Acevedo-Gutierrez, B. R. Tershy, and J. Urban-Ramirez. 2001. The diving behavior of blue and fin whales: Is dive duration shorter than expected based on oxygen stores? Comparative Biochemistry and Physiology, A 129:797-809.

Croll, D. A., C. W. Clark, A. Acevedo, B. Tershy, S. Flores, J. Gedamke, and J. Urban. 2002. Only male fin whales sing loud songs. Nature 417:809.

Cryan, PM. 2003. Seasonal Distribution Of Migratory Tree Bats (*Lasiurus* And *Lasionycteris*) In North America. Journal of Mammalogy: Vol. 84, No. 2 Pp. 579–593.

Cryan, P. M. and Brown, A. C. 2007. Migration of Bats past a Remote island offers clues toward problem of bat fatalities at wind turbines, Biol. Conserv, doi:10.1016/j.biocon.2007.05.019.

Cummings, W.C. and P.O. Thompson. 1971. Underwater sounds from blue whale, *Balaenoptera musculus*. JASA 50(4, Pt. 2):1193-1198.

Davenport, J. 1997. Temperature and the life-history strategies of sea turtles. Journal of Thermal Biology 22:479-488.

Davis, R.A., D.H. Thomson, and C.I. Malme. 1998. *Environmental Assessment of Seismic Exploration on the Scotian Shelf*, Canada/Nova Scotia Offshore Petroleum Board, Halifax, Nova Scotia, Canada.

DeBurlet, H.M. 1934. Vergleichende Anatomie des statoakustischen Organs, pp. 1,293-1,432. *In:* Handburch der vergleichenden Anatomie der Wirbeltiere. L. Bolk, E. Goppert, E. Kallius, and W. Lobosch (eds.). Urban an Schwarzenberg, Berlin.

Department of the Navy. 2007. Marine Resources Assessment for the Gulf of Mexico. Department of the Navy, U.S. Fleet Forces Command, Norfolk, Virginia. Contract #N62470-02-D-9997, CTO 0030. Prepared by Geo-Marine, Inc., Hampton, Virginia.

Derraik, J.G.B. 2002. "The Pollution of the Marine Environment by Plastic Debris: A Review," *Marine Pollution Bulletin* 44:842–852.

Deutsch, C., B. Ackerman, T. Pitchford, and S. Rommel. 2002. Trends in Manatee Mortality in Florida. Manatee Population Ecology and Management Workshop. Gainesville, FL. April 1–4, 2002. Unpublished abstract.

Dickerman, R.W., and R.G. Goelet. 1987. "Northern Gannet Starvation after Swallowing Styrofoam," *Marine Pollution Bulletin* 13:18–20.

Di lorio, L., M. Castellote, A.M. Warde, and C.W. Clark. 2005. Broadband sound production by feeding blue whales (*alaenoptera musculus*). Page 74 in Abstracts, Sixteenth Biennial Conference on the Biology of Marine Mammals. 12-16 December 2005. San Diego, California.

Dolphin, W.F. 1987. Dive behavior and estimated energy expenditures of foraging humpback whales in southeast Alaska. Can. J. Zool. 65:354-362.

Dunn, E.H., 1993, "Bird Mortality from Striking Residential Windows in Winter," *Journal of Field Ornithology* 64:302–309.

D'Vincent, C.G., R.M. Nilson, and R.E. Hanna. 1985. Vocalization and coordinated feeding behavior of the humpback whale in southeastern Alaska. Sci. Rep. Whales Res. Inst. 36:41-47.

Eckert, S.A. 1998. Perspectives on the use of satellite telemetry and other electronic technologies for the study of marine turtles, with reference to the first year long tracking of leatherback sea turtles. In: Seventeenth Annual Sea Turtle Symposium, Vol. NOAA Tech. Memo NMFS-SEFSC-415 (ed. S.P. Epperly and J. Braun), pp. 294. U.S. Department of Commerce, National Oceanic and Atmospheric Agency, National Marine Fisheries Service, Orlando, Florida.

Eckert, S.A. 1999. Habitats and migratory pathways of the Pacific leatherback sea turtle. Final Report to the National Marine Fisheries Service, Office of Protected Resources, pp. 15. Hubbs Sea World Research Institute, San Diego, CA.

Eckert, S.A. H.C. Liew, K.L. Eckert and E.H. Chan. 1996. Shallow water diving by leatherback turtles in the South China Sea. Chelonian Conservation and Biology 2:237-243.

Edds, P.L. 1982. Vocalizations of the blue whale, *Balaenoptera musculus*, in the St. Lawrence River. J. Mammal 63:345-347.
—. 1988. Characteristics of finback *Balaenoptera physalus* vocalizations in the St. Lawrence Estuary. Bioacoustics 1:131-14.

Elcock, D. 2006. Potential alternative energy technologies on the Outer Continental Shelf. ANL/EVS/TM/06-5, Argonne National Laboratory, Argonne, IL. Available at: http://ocsenergy.anl.gov/documents/docs/ANL_EVS_TM_06-5.pdf.

Ernst, C.H., R.W. Barbour, and J.E. Lovich. 1994. Turtles of the United States and Canada. Smithsonian Institute Press, Washington, D.C. 578 pp.

ESS Group, Inc. 2003. Scour analysis proposed offshore wind park. Nantucket Sound, Massachusetts. Prepared for Cape Wind Associates, L.L.C., Boston, MA, Sandwich, MA. Updated: 3-17-04. Available at: http://www.nae.usace.army.mil/projects/ma/ccwf/app4a.pdf.

ESS Group, Inc. 2006. Conceptual rock armor scour protection design, Cape Wind Project Nantucket Sound. Scour analysis proposed offshore wind park. Nantucket Sound, Massachusetts. Prepared for Cape Wind Associates, L.L.C., Boston, MA. February 13, 2006. Available at:
http://www.mms.gov/offshore/RenewableEnergy/DEIS/Report%20References%20-%20Cape%20Wind%20Energy%20EIS/Report%20No%204.1.1-6.pdf.

Fay, R.R. 1988. Hearing in vertebrates: a psychophysics handbook. Hill-Fay Associates, Winneka, IL. 621 p.

Fish and Wildlife Research Institute (FWRI). 2007a. Sea Turtle Nesting Data. Online at http://research.myfwc.com/features/view_article.asp?id=11812.

Fish and Wildlife Research Institute (FWRI). 2007b. Green Turtle Nesting in Florida. Online at http://research.myfwc.com/features/view_article.asp?id=2496.

Fish and Wildlife Research Institute (FWRI). 2007c. Species of Sea Turtles Found in Florida. Online at http://research.myfwc.com/features/view_article.asp?id=5182.

Fishermen's Energy of New Jersey, LLC. (FERN). 2011. Project Plan for the Installation, Operation and Maintenance of Buoy Based Environmental Monitoring Systems OCS Block 6931, NJ. Site Assessment Plan submitted to BOEMRE on January 11, 2011.

Florida Fish and Wildlife Conservation Commission (FFWCC). 2007. Florida's endangered species, threatened species, and species of special concern. Online at http://www.floridaconservation.org/imperiledspecies/pdf/Threatened-and-Endangered-Species-2007.pdf.

Frankel, A.S. 1994. Acoustic and visual tracking reveals distribution, song variability, and social roles of humpback whales in Hawaiian waters. Dissertation. University of Hawaii.

Frankel, A. S. 2002. Sound Production, Pages 1126-1138 *in* W. F. Perrin, B. Wursig, and J. G. M. Thewissen, eds. Encyclopedia of Marine Mammals. San Diego, Academic Press.

Frankel, A.S., J. Mobley, and L. Herman 1995. Estimation of auditory response thresholds in humpback whales using biologically meaningful sounds. Pages 55-70 *in* R.A Kastelein, J.A. Thomas, and P.E. Nachtigall, eds. Sensory Systems of Aquatic Mammals. Woerden, Neatherlands, De Spil Publishing.

Frisch, S. 2006. Personal communication via e-mail between Dr. Stefan Frisch, University of South Florida, Tampa, Florida and Dr. Amy Scholik, Geo-Marine, Inc., Hampton, Virginia, 11 January.

Frisch, S. and K. Frisch. 2003. Low frequency vocalizations in the Florida manatee (*Trichechus manatus latirostris*). Page 55 in Abstracts, Fifteenth Biennial Conference on the Biology of Marine Mammals. 14-19 December 2003. Greensboro, North Carolina.

Gabriele, C. and A. Frankel. 2002. The occurrence and significance of humpback whale songs in Glacier Bay, Southeastern Alaska. Arctic Research of the United States (16). pp. 42-47.

Gabriele, C. M., J. M. Straley, L. M. Herman, and R. J. Coleman. 1996. Fastest Documented Migration of a North Pacific Humpback Whale. Marine Mammal Science 12:457-464.

Gambell, R. 1985a. Fin whale *Balaenoptera physalus* (Linnaeus, 1758). In: Ridgway, S.H. and R. Harrison (eds.). Handbook of marine mammals Vol. 3: the sirenians and baleen whales. Academic Press, London, UKGeorge, J.C., C.W. Clark, G.M. Carroll, and W.T. Ellison. 1989. Observations on the ice-breaking and ice navigation behavior of migrating bowhead whales (*Balaena mysticetus*) near Point Barrow, Alaska. ARCTIC 42:24-30.

Gambell, R. 1985b. Sei whale *Balaenoptera borealis* (Lesson, 1828). In: Ridgway, S.H. and R. Harrison (eds.). Handbook of marine mammals Vol. 3: the sirenians and baleen whales. Academic Press, London, UK. Goold, J. C., and S. E. Jones. 1995. Time and frequency domain characteristics of sperm whale clicks. Journal of the Acoustical Society of America 98:1279-1291.

Gehring, J. L., P. Kerlinger, and A. M. Manville II. 2009. Communication towers, lights, and birds: successful methods of reducing the frequency of avian collisions. Ecological Applications 19: 505–514.

Garden State Offshore Energy, LLC (GSOE). 2010. Project Plan For the Deployment and Operation of a Meteorological Data Collection Buoy within Interim Lease Site, Block 7033, NJ. Site Assessment Plan submitted to BOEMRE on October 4, 2010.

Geraci, J.R., and D.J. St. Aubin. 1987. "Effects of Offshore Oil and Gas Development on Marine Mammals and Turtles," pp. 587–617 in *Long Term Environmental Effects of Offshore Oil and Gas Development*, D.F. Boesch and N.N. Rabalais, Elsevier Applied Science Publ. Ltd., London, England, and New York, NY.

Gerstein, E.R., L. Gerstein, S.E. Forsythe, and J.E. Blue. 1999. The underwater audiogram of the West Indian manatee (*Trichechus manatus*). Journal of the Acoustical Society of America 105(6):3575-3583.

Goff, J.A., J.A. Austin Jr., S. Gulick, S. Nordfjord, B. Christensen, C. Sommerfield, H. Olson, and C. Alexander. 2005. Recent and Modern Marine Erosion on the New Jersey Outer Shelf, Marine Geology, v. 216, p. 275-296.

Goold, J.C., and S.E. Jones. 1995. Time and frequency domain characteristics of sperm whale clicks. J. Acoust. Soc. Am. 98: 1279-1291.

Gordon, J.C.D., D. Gillespie, J. Potter, A. Frantzis, M. Simmonds, and R. Swift. 1998. The effects of seismic surveys on marine mammals. *In:* M.L. Tasker and C. Weir (eds.), Proceedings of the Seismic and Marine Mammals Workshop, London, 23-25 June 1998.

Gordon, J.C.D., D. Gillespie, L.E. Rendell and R. Leaper. 1996. Draft report on playback of ATOC like sounds to sperm whales *(Physeter macrocephalus)* off the Azores. Wildlife Conservation Research Unit, Dept. of Zoology, Oxford, UK.

Greene, K.E., J.L. Zimmerman, R.W. Laney, and J.C. Thomas-Blate. 2009. Atlantic coast diadromous fish habitat: A review of utilization, threats, recommendations for conservation, and research needs. Atlantic States Marine Fisheries Commission Habitat Management Series No. 9, Washington D.C.

Griffin, R.B. 1999. Sperm whale distributions and community ecology associated with a warm-core ring off Georges Bank. Marine Mammal Science 15(1):33-51.

Grow, J.A., R.E. Mattick, and J.S. Schlee. 1979. Multichannel Depth Sections over Outer Continental Shelf and Upper Continental Slope Between Cape Hatteras and Cape Cod. *In:* Geological and Geophysical Investigations of the Continental Margins. J.S. Watkins, L. Montadert, and P.W. Dickerson (eds.). AAPG Memoir 29:65-83.

Hamilton, P.K., G. S. Stone, and S.M. Martin. 1997. Note on a deep humpback whale *(Megaptera novaeangliae)* dive near Bermuda. Bull. Mar. Sci. 61:491-494.

Hanson, J., M. Helvey, and R. Strach. 2003. Non-fishing impacts to Essential Fish Habitat and recommended conservation measures: National Marine Fisheries Service (NOAA Fisheries). Available at: http://www.nwr.noaa.gov/Salmon-Habitat/Salmon-EFH/loader.cfm?url=/commonspot/security/getfile.cfm&pageid=24689.

Hartman, D.S. 1979. Ecology and behavior of the manatee (*Trichechus manatus*) in Florida. American Society of Mammalogists, Special Publication 5. Lawrence, Kansas: American Society of Mammalogists.

Harvey, M. 2000. Eastern Bat Species of Concern to Mining, Tennessee Technological University, Cookeville, Tennessee. In: Proceedings of Bat Conservation and Mining:. A Technical Interactive Forum held November 14-16, 2000. at the Airport Hilton, St. Louis, Missouri, edited by Kimery C. Vories, Dianne Throgmorton; sponsored by U.S. Dept. of the Interior, Office of Surface Mining, Bat Conservation International, Coal Research Center, Southern Illinois University at Carbondale: 35-40.

Haubold, E., C. Deutsch, and C. Fonnesbeck. 2006. Final Biological Status Review of the Florida Manatee (*Trichechus manatus latirostris*). Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute. St. Petersburg, FL.

Hawkins, A.D., and A.A. Myrberg, Jr. 1983. Hearing and sound communication under water, pp. 347-405. *In:* B. Lewis (ed.), Bioacoustics: A Comparative Approach. Academic Press, London.

Hays, G.C., J.D.R. Houghton, and A. Myers. 2004. Pan-Atlantic leatherback turtle movements. Nature 429: 522.

Heneman, B., and the Center for Environmental Education. 1988. *Persistent Marine Debris in the North Sea, Northwest Atlantic Ocean, Wider Caribbean Area, and the West Coast of Baja California. Final Report,* Marine Mammal Commission, Washington, DC.

Hiscock, K., et al., 2002, *High Level Environmental Screening Study for Offshore Wind Farm Developments—Marine Habitats and Species Project,* prepared by the Marine Biological Association for the Department of Trade and Industry, New and Renewable Energy Programme, England. Available at http://www.og.dti.gov.uk/offshore-wind-sea/reports/Windfarm_Report.pdf. Accessed Aug. 3, 2006.

Horwood, J. 2002. Sei Whal, Pages 1069-1071 *in* W.F. Perrin, B. Wursig, and H.G.M. Theweissen (editors). Encyclopedia of Marine Mammals. Academic Press, San Diego, California.

Houser, D. S., D.A. Helweg, and P.W. Moore. 2001. A bandpass filter-bank model of auditory sensitivity in the humpback whale. Aquatic Mammals 27.2: 82-91.

IFAW. 2001. Report of the Workshop on Right Whale Acoustics: Practical Applications in Conservation, Pages 23 *in* D. Gillespie, and R. Leaper, eds. Yarmouth Port, MA, International Fund for Animal Welfare.

Jaquet, N., H. Whitehead, and M. Lewis. 1996. Coherence between 19th century sperm whale distributions and satellite-derived pigments in the tropical Pacific. Marine Ecology Progress Series 145:1-10.

Jaquet, N., S. Dawson, and L. Douglas. 2001. Vocal behavior of male sperm whales: why do they click? Journal of the Acoustical Society of America 109:2254-2259.

Jensen, A.S., and G.K. Silber. 2004. *Large Whale Ship Strike Database,* NOAA Technical Memorandum NMFS-OPR-January 2004, Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S Department of Commerce, Silver Spring, MD.

Jonsgård, A. and K. Darling. 1977. On the biology of the eastern North Atlantic sei whale, *Balaenoptera borealis*. Rep. Int. Whal. Commn., Spec. Issue 1:124-129.

Johnson, Korie A. 2002. *Characterization of the Fishing Practices and Marine Benthic Ecosystems of the Northeast U.S. Shelf* (NOAA Technical Memo NMFS-NE-181, 2004)

Kawamura, A. 1994. A review of baleen whale feeding in the Southern Ocean. Rep. Int. Whal. Commn. 44:261-271.

Keinath, J.A., and J.A. Musick. 1993. Movements and diving behavior of a leatherback turtle, *Dermochelys coriacea*. Copeia 1993(4):1010-1017.

Kenney, R. D. 2002. North Atlantic, North Pacific, and Southern Right Whales (*Eubalaena glacialis, E. japonica,* and *E. australis*) *in* W. F. Perrin, B. Würsig, and H. G. M. Thewissen, eds. Encyclopedia of Marine Mammals. San Diego, CA, Academic Press.

Ketten, D.R. 2000. Cetacean Ears, Pages 43-108 *in* W. W. L. Au, A. N. Popper, and R. R. Fay, eds. Hearing by Whales and Dolphins. New York, Springer-Verlag.

Ketten, D.R. 1998. Marine mammal auditory systems: A summary of audiometric and anatopical data and its implications for underwater acoustic impacts. NOAA Technical Memorandum NMFS-SWFSC-256:1-74.

Kirk, J., and C.H. Nelson. 1984. Side-scan Sonar Assessment of Gray Whale Feeding in the Bering Sea. *Science* 225:1150–1152.

Klem, D., Jr. 1989. Bird-Window Collisions. *Wilson Bulletin* 101:606–620.

Klem, D., Jr. 1990. "Collisions between Birds and Windows: Mortality and Prevention," *Journal of Field Ornithology* 61:120–128.

Knowlton, A.R., C.W. Clark, and S.D. Kraus. 1991. Sounds recorded in the presence of sei whales, *Balaenoptera borealis*. Abstracts of the 9th Biennial Conference on the Biology of Marine Mammals, Chicago, IL, December 1991.

Kraus, S.D., R.D. Kenney, A.R. Knowlton, and J.N. Ciano. 1993. Endangered right whales of the southwestern North Atlantic. OCS Study BOEMRE 93-0024. Herndon, Virginia: Minerals Management Service.

Ladich, F., and Popper, A.N. 2004. Parallel evolution in fish hearing organs. In: *Evolution of the Vertebrate Auditory System* (eds. G.A. Manley, A.N. Popper, and R.R. Fay). Springer-Verlag, New York, 95-127.

Laist, D.W., A.R. Knowlton, J.G. Mead, A.S. Collet, and M. Podesta. 2001. "Collisions between Ships and Whales," *Marine Mammal Science* 17(1):35–75.

Laurie, A. 1933. Some aspects of respiration in fin and blue whales. Discovery Reports 7:365-406.

Leaper, R. and D. Gillespie, eds. 2006. Report of the Second Workshop on Right Whale Acoustics: Practical Applications in Conservation. 4 November 2005. New Bedford Whaling Museum, Massachusetts.

Leatherwood, S. and R.R. Reeves. 1983. Sierra club handbook of whales and dolphins. Sierra Club Books, San Francisco, CA.

Lefevre, L., T. O'Shea, G. Rathbun, and R. Best. 1989. Distribution, Status, and Biogeography of the West Indian Manatee. Biogeography of the West Indies 1989:567–610.

Lenhardt, M.L. 1982. Bone conduction hearing in turtles. J. Aud. Res. 22:153-160.

Lenhardt, M.L., and S.W. Harkins. 1983. Turtle shell as an auditory receptor. J. Aud. Res. 23:251-260.

Lenhardt, M.L., R.C. Klinger, and J.A. Musick. 1985. Marine turtle middle-ear anatomy. J. Aud. Res. 25:66-72.

Lenhardt, M.L. 1994. Seismic and very low frequency sound induced behaviors in captive loggerhead marine turtles (*Caretta caretta*). In Bjorndal, K.A., A.B. Dolten, D.A. Johnson, and P.J. Eliazar (Compilers). 1994. Proceedings of the Fourteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-351, 323 pp.

Lockyer, C. 1984. Review of baleen whale (Mysticeti) reproduction and implications for management. Rep. Int. Whal. Commn., Spec. Issue 6:27-50.

Luschi, P., G.C. Hays, and F. Papo. 2003. A review of long-distance movements by marine turtles, and the possible role of ocean currents. OIKOS 103: 293-302.

Lutcavage, M.E., P. Plotkin, B. Witherington, and P.L. Lutz. 1997. "Human Impacts on Sea Turtle Survival," pp. 387–410 in *The Biology of Sea Turtles*, P.L. Lutz and J.A. Musick (editors), CRC Press, Boca Raton, FL.

Mackintosh, N.A. 1965. The stocks of whales. Fishing News (books) Ltd., London.

Madsen, P. T., and B. Møhl. 2000. Sperm Whales (*Physeter catodon L.*1758) Do Not React to Sounds from Detonators. Journal of the Acoustical Society of America 107:668-671.

Madsen, P. T., R. Payne, N. U. Kristiansen, M. Wahlberg, I. Kerr, and B. Mohl. 2002. Sperm whale sound production studied with ultrasound time/depth-recording tags. Journal of Experimental Biology 205:1899-1906.

Madsen, P.T., M. Wahlberg, J. Tougaard, K. Lucke, and P. Tyack. 2006. Wind turbine underwater noise and marine mammals: Implications of current knowledge and data needs. Marine Ecology Progress Series 309:279-295.

Malme, C.I., P.R. Miles, C.W. Clark, P. Tyack, and J.E. Bird. 1984. *Investigations of the Potential Effects of Underwater Noise from Petroleum Industry Activities on Migrating Gray Whale Behavior/Phase II: January 1984 Migration,* BBN Rep. 5586, U.S. Department of the Interior, Minerals Management Service, Anchorage, AK.

Malme, C.P., P.R. Miles, P.Tyack, C.W. Clark, and J.E. Bird. 1985. Investigation of the potential effects of underwater noise from petroleum industry activities on feeding humpback whale behavior. Report No. 5851, prepared by Bolt, Beranek, and Newman Inc., Cambridge, USA for U.S. Minerals Management Service, Alaska OCS Office, Anchorage, USA

Manley, G. 1970. Comparative studies of auditory physiology in reptiles. Z. Vergl. Physiol. 67:363-381.

Mann, D.A., Z. Lu, M.C. Hastings, and A.N. Popper. 1998. Detection of ultrasonic tones and simulated dolphin echolocation clicks by a teleost fish, the American shad (*Alosa sapidissima*). Journal of the Acoustical Society of America 104:562-568.

Mann, D.A., D.M. Higgs, W.N. Tavolga, M.J. Souza, and A.N. Popper. 2001. Ultrasound detection by clupeiforme fishes. Journal of the Acoustical Society of America 109:3048-3054.

Mate, B.R., K.M. Stafford, and D.K. Ljungblad. 1994. "A Change in Sperm Whale (*Physeter macrocephalus*) Distribution Correlated to Seismic Surveys in the Gulf of Mexico," *Journal of the Acoustical Society of America* 96(5):3268–3269.

Maser, C., B.R. Mate, J.F. Franklin, and C.T. Dyrness. 1981. Natural history of Oregon coast mammals. U.S. Department of Agriculture. For. Ser. Gen. Tech. Rep. PNW-133, Portland, OR.

Mate, B. R., B. A. Lagerquist, and J. Calambokidis. 1999. Movements of North Pacific Blue Whales During the Feeding Season off Southern California and Their Southern Fall Migration. Marine Mammal Science 15:1246-1257.

Mate, B. and M. Baumgartner. 2001. Summer feeding season movements and fall migration of North Atlantic right whales from satellite-monitored radio tags. Page 137 in Abstracts, Fourteenth Biennial Conference on the Biology of Marine Mammals. 28 November-3 December 2001. Vancouver, British Columbia.

Mate, B.R., S.L. Nieukirk, and S.D. Kraus. 1997. Satellite-monitored movements of the northern right whale. J. Wildl. Manage. 61:1393-1405.

Mate, B.R., S.L. Nieukirk, R.S. Mesecar, and T.J. Martin. 1992. Application of remote sensing for tracking large cetaceans: Atlantic right whales. Report Contract No. 14-12-0001-30411, U.S. Minerals Management Service.

Matthews, J.N., S. Brown, D. Gillespie, R. McManaghan, A. Moscrop, D. Nowacek, R. Leaper, T. Lewis, and P. Tyack. 2001. Vocalization rates of the North Atlantic right whale (*Eubalaena glacialis*). Journal of Cetacean Research and Management 3:271-282.

McCauley, R., J. Fewtrell, and A. Popper. 2000. "Marine Seismic Surveys—A Study of Environmental Implications," *Australian Petroleum Production & Exploration Association Journal* 2000: 692–708.

McDonald, M.A., J.A. Hildebrand, and S.C. Webb. 1995. Blue and fin whales observed on a seafloor array in the northeast Pacific. J. Acoust. Soc. Am. 98: 712-721.

McDonald, M.A., J.A. Hildebrand, S.M. Wiggins, D. Thiele, D. Glasgow, and S.E. Moore. 2005. Sei whale sounds recorded in the Antarctic. Journal of the Acoustical Society of America 118(6): 3941-3945.

McDonald, M. A., J. Calambokidis, A. M. Teranishi, and J. A. Hildebrand. 2001. The acoustic calls of blue whales off California with gender data. Journal of the Acoustical Society of America 109: 1728-1735.

Mellinger, D. K. 2004. A comparison of methods for detecting right whale calls. *Canadian Acoustics.* 32:55-65.

Meylan, A., B. Schroeder, and A. Mosier. 1995. Sea Turtle Nesting Activity in the State of Florida 1979–1992. (Florida Marine Research Publications, No. 52.) State of Florida, Department of Environmental Protection, Florida Marine Research Institute.

Meylan, A. and P. Meylan. 1999. Introduction to the Evolution, Life History, and Biology of Sea Turtles. (IUCN/SSC Marine Turtle Specialist Group Publication No. 4.)

Moein, S.E., J.A. Musick, J.A. Keinath, D.E. Barnard, M. Lenhardt and R. George. 1995. "Evaluation of Seismic Sources for Repelling Sea Turtles from Hopper Dredges," pp. 90–93 in Technical Report CERC-95, *Sea Turtle Research Program: Summary Report,* L.Z. Hales (comp.), U.S. Army Engineer Division, South Atlantic, Atlanta, GA, and U.S. Naval Submarine Base, Kings Bay, GA.

Mohl, B., M. Wahlberg, P. Madsen, A. Heerfordt, and A. Lund. 2003. The Monopulsed Nature of Sperm Whale Clicks. Journal of the Acoustical Society of America 114:1143-1154.

Mohl, B., M. Wahlberg, P. T. Madsen, L. A. Miller, and A. Surlykke. 2000. Sperm whale clicks: Directionality and source level revisited. Journal of the Acoustical Society of America 107:638-648.

Montgomery, J.C., S. Coombs, and M. Halstead. 1995. Biology of the mechanosensory lateral line. Reviews in Fish Biology and Fisheries 5:399-416.

Moore, S.E. and D.P. DeMaster. 1999. Effects of global climate change on the ecology of whales in the Arctic. International Whaling Commission, Grenada, National Marine Mammal Laboratory, Seattle, WA.

Mrosovsky, N. 1972. The water-finding ability of sea turtles: Behavioral studies and physiological speculation. Brain Behav. Evol. 5:202-205.

Murison, L.D. and D.E. Gaskin. 1989. The distribution of right whales and zooplankton in the Bay of Fundy, Canada. Canadian Journal of Zoology 67:1411-1420.

Myrberg, Jr., A.A. 1980. Ocean noise and the behavior of marine animals: relationships and implications. In: Diemer, F.P., P.J. Vernberg, N.P. Barroy, and D.Z. Mirkes (eds.) advanced concepts in ocean measurements for marine biology. Univ. South Carolina Press, Columbia, SC pp. 461-491.

Myrberg, A. 1981. Sound communication and interceptions by fishes, pp. 395-426. *In:* W.N. Tavolga, A.N. Popper, and R.R. Fay (eds.), Hearing and Sound Communication in Fishes. Springer-Verlag, New York.

National Marine Fisheries Service (NMFS). 2002. "Small Takes of Marine Mammals Incidental to Specified Activities; Seismic Reflection Data off Southern California," *Federal Register* 67(121):42541–42547, June 24.

NMFS. 2006b. Right Whales (*Eubalaena glacialis* / *Eubalaena australis*). Office of Protected Resources. Online at http://www.nmfs.noaa.gov/pr/species/mammals/ cetaceans/rightwhale.htm.

NMFS. 2006c. Environmental Impact Statement to Implement the Operational Measures of the North Atlantic Right Whale Ship Strike Reduction Strategy: Draft Environmental Impact Statement. Silver Springs, MD. July.

NMFS. 2007b. Sperm Whales (*Physeter macrocephalus*). Office of Protected Resources. Online at http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/spermwhale.htm.

NMFS. 2009. ESA Section 7 Consultation Regarding Non-Competitive Leases for Wind Resource Data Collection on the Northeast Outer Continental Shelf. NMFS Northeast Regional Office Letter from Patricia Kurkul to James Kendall dated May 14, 2009.

NMFS. 2010a. Shortnose Sturgeon Species Profile. Office of Protected Resources. Online at: http://www.nmfs.noaa.gov/pr/species/fish/shortnosesturgeon.htm, accessed December 30, 2010.

NMFS. 2010b. Proactive Conservation Program - Species of Concern. Online at: www.nmfs.noaa.gov/pr/species/concern, accessed January 2, 2011.

NMFS. 2010c. ESA Section 7 Consultation Regarding Non-Competitive Leases for Wind Resource Data Collection on the Northeast Outer Continental Shelf Regarding Bluewater Wind Met Tower Construction. NMFS Northeast Regional Office Letter from Patricia Kurkul to James Kendall dated September 14, 2010.

National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS). 2007a. Loggerhead Sea Turtle (*Caretta caretta*) 5-Year Review: Summary and Evaluation. National Marine Fisheries Service, Office of Protected Resources, Silver Spring, Maryland, and U.S. Fish and Wildlife Service, Southeast Region, Jacksonville Ecological Services Field Office, Jacksonville, Florida. August 2007.

NMFS and USFWS. 2007b. Leatherback Sea Turtle (*Dermochelys coriacea*) 5-Year Review: Summary and Evaluation. National Marine Fisheries Service, Office of Protected Resources, Silver Spring, Maryland, and U.S. Fish and Wildlife Service, Southeast Region, Jacksonville Ecological Services Field Office, Jacksonville, Florida. August 2007.

NMFS and USFWS. 2007c. Kemp's Ridley Sea Turtle (*Lepidochelys kempii*) 5-Year Review: Summary and Evaluation. National Marine Fisheries Service, Office of Protected Resources, Silver Spring, Maryland, and U.S. Fish and Wildlife Service, Southeast Region, Jacksonville Ecological Services Field Office, Jacksonville, Florida. August 2007.

NMFS and USFWS. 2007d. Green Sea Turtle (*Celonia mydas*) 5-Year Review: Summary and Evaluation. National Marine Fisheries Service, Office of Protected Resources, Silver Spring, Maryland, and U.S. Fish and Wildlife Service, Southeast Region, Jacksonville Ecological Services Field Office, Jacksonville, Florida. August 2007.

NMFS and USFWS. 2007e. Hawksbill Sea Turtle (*Eretmochelys imbricata*) 5-Year Review: Summary and Evaluation. National Marine Fisheries Service, Office of Protected Resources, Silver Spring, Maryland, and U.S. Fish and Wildlife Service, Southeast Region, Jacksonville Ecological Services Field Office, Jacksonville, Florida. August 2007.

NMFS and USFWS. 1998a. Recovery Plan for U.S. Pacific Populations of Green Turtles (*Chelonia mydas)*. National Marine Fisheries Service, Silver Spring, MD.

NMFS and USFWS. 1998b. Recovery Plan for U.S. Pacific Populations of the Hawksbill Turtle (*Eretmochelys imbricata)*. National Marine Fisheries Service, Silver Spring, MD.

NMFS and USFWS. 1998c. Status Review of Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*). National Marine Fisheries Service, Silver Spring, MD.

NMFS and USFWS. 1993. Recovery Plan for Hawksbill Turtles in the U.S. Caribbean Sea, Atlantic Ocean, and Gulf of Mexico. National Marine Fisheries Service, St. Petersburg, Florida.

NMFS and USFWS. 1992a. Recovery Plan for Leatherback Turtles in the U.S. Caribbean, Atlantic and Gulf of Mexico. National Marine Fisheries Service, Washington D.C.

NMFS and USFWS. 1992b. Recovery Plan for the Kemp's Ridley Sea Turtle. National Marine Fisheries Service, Washington D.C.

NMFS and USFWS. 1991a. Recovery Plan for U.S. Population of Loggerhead Turtle. National Marine Fisheries Service, Washington, D.C.

NMFS and USFWS. 1991b. Recovery Plan for U.S. Population of Atlantic Green Turtle. National Marine Fisheries Service, Washington, D.C.

National Oceanic and Atmospheric Administration (NOAA). 2003. *Oil and Sea Turtles*, G. Shigenaka (editor), National Ocean Service, Office of Response and Restoration, Washington, DC.

National Research Council (NRC). 2003. Ocean Noise and Marine Mammals. National Academy Press. Washington D.C.

Nedwell J R , Parvin S J, Edwards B, Workman R , Brooker A G and Kynoch J E. 2007. Measurement and interpretation of underwater noise during construction and operation of offshore windfarms in UK waters. Subacoustech Report No. 544R0738 to COWRIE Ltd. ISBN: 978-0-9554279-5-4.

Nemoto, T. and A. Kawamura. 1977. Characteristics and food habits and distribution of baleen whales with special reference to the abundance of North Pacific sei and Bryde's whales. Rep. Int. Whal. Commn., Spec. Issue 1:80-87.

New Jersey Department of Environmental Protection (NJDEP). 2010. *Ocean/Wind Power Ecological Baseline Studies Final Report: January 2008 – December 2009*. Available online at: http://www.nj.gov/dep/dsr/ocean-wind/report.htm

Niezrecki, C., R. Phillips, M. Meyer, and D.O. Beusse. 2003. Acoustic detection of manatee vocalizations. Journal of the Acoustical Society of America 114(3):1640-1647.

Nowacek, D.P., B.M. Casper, R.S. Wells, S.M. Nowacek, and D.A. Mann. 2003. Intraspecific and geographic variation of West Indian manatee (*Trichechus manatus spp.*) vocalizations (L). Journal of the Acoustical Society of America 114(1):66-69.

Nowacek, S.M., and R.S. Wells. 2001. "Short-Term Effects of Boat Traffic on Bottlenose Dolphins, *Tursiops truncatus*, in Sarasota Bay, Florida," *Marine Mammal Science* 17:673–688.

Nowacek, D.P., M.P. Johnson, and P.L. Tyack. 2004. North Atlantic right whales (*Eubalaena glacialis*) ignore ships but respond to alerting stimuli. Proceedings of the Royal Society B: Biological Sciences 271:227-231.

O'Hara, J., and J.R. Wilcox. 1990. "Avoidance Responses of Loggerhead Turtles, *Caretta caretta*, to Low Frequency Sound," *Copeia* 1990(2):564–567.

O'Shea, T.J. and L.B. Pøche. 2006. Aspects of underwater sound communication in Florida manatees (*Trichechus manatus latirostris*). Journal of Mammalogy 87(6):1061-1071.

O'Shea, T.J., B.B. Ackerman, and H.F. Percival, eds. 1995. Population biology of the Florida manatee. Information and Technology Report 1. Washington, D.C.: National Biological Service.

Ocean and Coastal Consultants, Inc. 2006. Field report-revised. May 25, 2006. Available at: http://www.mms.gov/offshore/PDFs/CWFiles/SL-OCC2006SSCSInstallation.pdf.

Panigada, S., G. Notarbartolo di Sciara, M. Zanardelli Panigada, A. Airoldi, J. Fabrizio Borsani, M. Jahoda, G. Pesante, and E. Revelli. 1999. Distribtion and occurrence of fin whales in the Ligurian Sea between 1990-1999. Tethys Research Institute. Italy.

Papastavrou, V., S. C. Smith, and H. Whitehead. 1989. Diving behaviour of the sperm whale, *Physeter macrocephalus*, off the Galapagos Islands. Canadian Journal of Zoology 67:839-846.

Parks, S.E., D.R. Ketten, J.T. O'Mally, and J. Arruda. 2001. Hearing in the North Atlantic right whale: Anatomical predictions. J. Acous. Soc. Am. 115(5): 2442.

Parks, S.E., D.R. Ketten, J. Trehey O'Malley, and J. Arruda. 2004. Hearing in the North Atlantic right whale: Anatomical predictions. Journal of the Acoustical Society of America 115(5, Part 2):2442.

Parks, S.E., P.K. Hamilton, S.D. Kraus, and P.L. Tyack. 2005. The gunshot sound produced by male North Atlantic right whales (*Eubalaena glacialis*) and its potential function in reproductive advertisement. Marine Mammal Science 21(3):458-475.

Parks, S.E. and P.L. Tyack. 2005. Sound production by North Atlantic right whales (*Eubalaena glacialis*) in surface active groups. J. Acoust. Soc. Am. 117(5): 3297-3306.

Patterson, B. and G.R. Hamilton. 1964. Repetitive 20 cycle per second biological hydroacoustic signals at Bermuda In: Tavolga, W.N. (ed.). Marine bio-acoustics. Vol. 1. Pergamon Press, Oxford.

Pavan, G., T. J. Hayward, J. F. Borsani, M. Priano, M. Manghi, C. Fossati, and J. Gordon. 2000. Time patterns of sperm whale codas recorded in the Mediterranean Sea 1985-1996. Journal of the Acoustical Society of America 107:3487-3495.

Payne, K., and R.S. Payne. 1985. Large-scale changes over 17 years in songs of humpack whales in Bermuda. Z. Tierpsychol. 68:89-114.

Phillips, R., C. Niezrecki, and D.O. Beusse. 2004. Determination of West Indian manatee vocalization levels and rate. Journal of the Acoustical Society of America 115(1):422-428.

Plotkin, P.T. (Editor). 1995. National Marine Fisheries Service and the U.S. Fish and Wildlife Service Status Reviews for Sea Turtles Listed Under the Endangered Species Act of 1973. National Marine Fisheries Service, Silver Spring, MD.

Plotkin, P.T. 2003. Adult Migrations and Habitat Use *in* The Biology of Sea Turtles Volume II. CRC Press. Pp. 225-241.

Poag, C.W. and P.C. Valentine. 1988. Mesozoic and Cenozoic Stratigraphy of the United States Atlantic Continental Shelf and Slope: *In* Sheridan, R.E. and Grow, J.A., eds., The Geology of North America, Volume I-2, The Atlantic Continental Margin, Geological Society of America, p. 67-85.

Popper, A.N., R.R. Fay, C. Platt, and O. Sand. 2003. Sound detection mechanisms and capabilities of teleost fishes. In: *Sensory Processing in Aquatic Environments* (eds. S.P. Collin and N.J. Marshall). Springer-Verlag, New York, pp. 3-38.

Popper, A.N. and S. Coombs. 1982. The morphology and evolution of the ear in Actinopterygian fishes. Amer. Zool. 22:311-328.

Popper, A.N. and R.R. Fay. 1973. Sound detection and processing by teleost fishes: a critical review. J. Acoust. Soc. Amer. 53:1515-1529.

Popper, A.N. and R.R. Fay. 1993. Sound detection and processing by fish: Critical review and major research questions. Brain Behav. Evol. 41:14-38

Popper, A.N. and R.R. Fay. 1997. Evolution of the ear and hearing: Issues and questions. Brain Behav. Evol. 50:213-221.

Popper, A.N. and R.R. Fay. 1999. The auditory periphery in fishes. In: Fay, R.R. and A.N. Popper (eds.). Comparative hearing: fish and amphibians. Springer-Verlag, NY. p. 43-100.

Pritchard, P.C.H. 1997. Evolution, phylogeny, and current status In: Lutz, P., and J. Musick (eds.). The biology and conservation of sea turtles. CRC Press, Inc., Boca Raton, FL.

Reeves, R. R., and H. Whitehead. 1997. Status of the sperm whale, Physeter macrocephalus, in Canada. Canadian Field-Naturalist 111:293-307.

Reyff, J.A. 2003. Underwater sound levels associated with seismic retrofit construction of the Richmond-Sand Rafael Bridge. Document in support of Biological Assessment for the Richmond-Sand Rafael Bridge Seismic Safety Project. 18 p.

Reyonlds, J.E. and J.A. Powell. 2002. Manatees, Pages 709-720 *in* W. F. Perrin, B. Würsig, and H. G. M. Thewissen, eds. Encyclopedia of Marine Mammals. San Diego, Academic Press.

Rice, D.W. 1989. Sperm Whale -- *Physeter macrocephalus* Linnaeus, 1758, Pages 177-234 *in* S. H. Ridgway, and R. Harrison, eds. Handbook of Marine Mammals: Volume 4: River Dolphins and the Larger Toothed Whales. New York, Academic Press.

Rice, D.W. 1977. Synopsis of biological data on the sei whale and Bryde's whale in the eastern North Pacific. Rep. Int. Whal. Commn., Spec. Issue 1:92-97.

Richardson, W.J., C.R. Greene, Jr., C.I. Malme, and D.H. Thomson. 1995. Marine mammals and noise. Academic Press, San Diego, CA. 576 pp.

Ridgway, S.H., E.G. Wever, J.G. McCormick, J. Palin, and J.H. Anderson. 1969. Hearing in the giant sea turtle, *Chelonia mydas*. Proc. Nat. Acad. Sci. 64:884-890.

Ridgway, S. H., and D. A. Carder. 2001. Assessing hearing and sound production in cetaceans not available for behavioral audiograms: Experiences with sperm, pygmy sperm, and gray whales. Aquatic Mammals 27:267-276.

Riggs, S.R. and D.F. Belknap. 1988. Upper Cenozoic Processes and Environments of Continental Margin Sedimentation: Eastern United States: *In* Sheridan, R.E. and Grow, J.A., eds., The Geology of North America, Volume I-2, The Atlantic Continental Margin, Geological Society of America, p. 131-176.

Rivers, J.A. 1997. Blue whale, *Balaenoptera musculus*, vocalizations from the waters off central California. Mar. Mamm. Sci. 13:186-195.

Rogers, P.H. and M. Cox. 1988. Underwater sound as a biological stimulus. p. 131-149 In: J. Atema, Fay, R.R., Popper, A.N., Tavolga, W.N., eds. Sensory biology of aquatic animals. New York: Springer-Verlag.

Ryan, P.G. 1987. "The Incidence and Characteristics of Plastic Particles Ingested by Sea Birds," *Marine and Environmental Research* 23:175–206.

Ryan, P.G. 1988. "Effects of Ingested Plastic on Seabird Feeding: Evidence from Chickens," *Marine Pollution Bulletin* 19:174–176.

Ryan, P.G. 1990. "The Effects of Ingested Plastic and Other Marine Debris on Seabirds," pp. 623–634 in *Proceedings of the Second International Conference on Marine Debris, April 2–7, 1989, Honolulu, HI*, R.S. Shomura and M.L. Godfrey (editors), NOAA Technical Memorandum NMFS-NOAA-TM-NMFS-SWFSC-154, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Washington, DC.

Saliva, J.E. 1993. Caribbean Roseate Tern Recovery Plan. U.S. Fish and Wildlife Service, Caribbean Field Office, Boqueron, Puerto Rico.

Schaeff, C.M., S.D. Kraus, M.W. Brown, J.S. Perkins, R. Payne, and B.N. White. 1997. Comparison of genetic variability of north and south Atlantic right whales (*Eubalaena*) using DNA fingerprinting. Can. J. Zool/Rev. Can. Zool. 75(7): 1073-1080.

Schilling, M.R., I. Seipt, M.T. Weinrich, A.E. Kuhlbery, and P.J. Clapham. 1992. Behavior of individually-identified sei whales *Balaenoptera borealis* during an episodic influx into the southern Gulf of Maine in 1986. U.S. NMFS Fish Bull 90:749-755.

Seabed Scour Control Systems Ltd. 2008. How seabed scour control systems work. Internet website: http://www.scourcontrol.co.uk/HowitWorks/tabid/103/Default.aspx. Assessed: August 26, 2008.

Schellart, N.A.M., and A.N. Popper. 1992. Functional aspects of the evolution of the auditory system of actinopterygian fish. In: Webster, D.B., R.R. Fay, and A.N. Popper (eds.). Comparative evolutionary biology of hearing.

Sharpe, F.A. and L.M. Dill. 1997. The behavior of Pacific herring schools in response to artificial humpback whale bubbles. Can. J. Zool. 75:725-730.

Shire, G.G., K. Brown, and G. Winegrad. 2000. *Communication Towers: A Deadly Hazard to Birds*, American Bird Conservancy, Washington, D.C.

Sigurjonsson, J. 1995. On the life history and autecology of North Atlantic rorquals In: Blix, A.S., L. Walloe, and O. Ultang (eds.). Developments in marine biology, 4. Whales, seals, fish, and man. International Symposium on the Biology of Marine Mammals in the Northeast Atlantic, Tromso, Norway.

Silber, G.K. 1986. The relationship of social vocalizations to surface behavior and aggression in the Hawaiian humpback whale (*Megaptera novaeangliae*). Canadian Journal of Zoology 64:2075-2080.

Simão, S.M. and S.C. Moreira. 2005. Vocalizations of female humpback whale in Arraial do Cabo (RJ, Brazil). Marine Mammal Science 21(1):150-153.

Smith, P.C. 1996. Nearshore Ridges and Underlying Pleistocene Sediments on the Inner Continental Shelf of New Jersey. Master of Science Thesis, Department of Geologic Sciences, Rutgers, The State of New Jersey, New Brunswick, October 1996, 157pp.

Smith, T.D., J. Allen, P.J. Clapham, P.S. Hammond, S. Katona, F. Larsen, J. Lien, D. Mattila, P.J. Palsbøll, J. Sigurjónsson, P.T. Stevick and N. Øien. 1999. An ocean-basin-wide mark-recapture study of the North Atlantic humpback whale (*Megaptera novaeangliane*) Mar. Mam. Sci. 15(1):1-32.

Spotila, J. 2004. Sea Turtles: A Complete Guide to Their Biology, Behavior, and Conservation. John Hopkins University Press, MD.

Spotila, J.R., M.P. O'Connor, and F.V. Paladino. 1997. In: Lutz, P., and J. Musick (eds.). The biology of sea turtles. CRC Press, Inc., Boca Raton, FL.

Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Green Jr., D. Kastak, D. R. Ketten, J.H. Miller, P.E. Nachtigall, W.J. Richardson, J.A. Thomas, and P.L. Tyack. 2007. Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. Aquatic Mammals. 33(4): 415-421.

Southwest Windpower. 2008. Off shore platforms. Internet website: http://www.windenergy.com/applications/off_shore_platforms.htm. Accessed: August 20, 2008.

Stafford, K.M., C.G. Fox and D.S. Clark. 1998. Long-range acoustic detection and localization of blue whale calls in the northeast Pacific ocean. JASA 104(6):3616-3625.

Stafford, K.M., S.L. Nieukirk. 1999a. An acoustic link between blue whales in the eastern tropical Pacific and the northeast Pacific. Mar. Mamm. Sci. 15(4):1258-1268.

Stafford, K.M., S.L. Nieukirk and C.G. Fox. 1999b. Low-frequency whale sounds recorded on hydrophones moored in the eastern tropical Pacific. JASA 106(6):3687-3698.

Stafford, K. M., S. L. Nieukirk, and C. G. Fox. 2001. Geographic variation in blue whale calls in the North Pacific. Journal of Cetacean Research and Management 3:65-76.

Steel, C. and J.G. Morris. 1982. The West Indian manatee: An acoustic analysis. American Zoologist 22(4):925-926.

Strong, C.S. 1990. Ventilation patterns and behavior of balaenopterid whales in the Gulf of California, Mexico. MS thesis, San Francisco State University, CA.

Texas Parks and Wildlife Department. 2008. Eastern Red Bat (*Lasiurus borealis*). http://www.tpwd.state.tx.us/huntwild/wild/species/eastred/ Access December 2008.

The Nature Conservancy (TNC). 2011. Public Comment Received on BOEMRE Notice of Intent to Prepare and Environmental Assessment. Data summary of TNC Northwest Atlantic Marine Ecoregional Assessment.

Thewissen, H. G. M. 2002. Hearing, Pages 570-574 in W. F. Perrin, B. Wursig, and J. G. M. Thewissen., eds. Encyclopedia of Marine Mammals. San Diego, Academic Press.

Thode, A., D. K. Mellinger, S. Stienessen, A. Martinez, and K. Mullin. 2002. Depth-dependent acoustic features of diving sperm whales (*Physeter macrocephalus*) in the Gulf of Mexico. Journal of the Acoustical Society of America 112:308-321.

Thompson, P.O., L.T. Findley, and O. Vidal. 1992. 20-Hz pulses and other vocalizations of fin whales, *Balaenoptera physalus*, in the Gulf of California, Mexico. JASA 92:3051-3057.

Thompson, P.O., W.C. Cummings, and S.J. Ha. 1986. Sounds, source levels, and associated behavior of humpback whales, southeast Alaska. JASA 80(3):735-740.

Thompson T.J., H.E. Winn, and P.J. Perkins. 1979. Mysticete sounds In: Winn, H.E. and B.L. Olla (eds.). Behavior of marine animals. Vol. 3. Cetaceans. Plenum, NY. 438 p.

Thompson, P.O. and W.A. Friedl. 1982. A long term study of low frequency sounds from several species of whales off Oahu, Hawaii. Cetology 45:1-19.

Thomsen, F., K. Lüdemann, R. Kafemann, and W. Piper. 2006. Effects of Offshore Wind Farm Noise on Marine Mammals and Fish, prepared by Biola, Hamburg, Germany, for COWRIE, Ltd., July. Available at http://www.offshore-wind.de/page/fileadmin/offshore/documents/Naturschutz/Voegel/Effects_of_offshore_wind_farm_noise_on_marine-mammals_and_fish.pdf. Accessed December 4, 2007.

Thomson, D.H. and W.J. Richardson. 1995. Marine mammal sounds. Pages 159-204 in Richardson, W.J., C.R. Greene, Jr., C.I. Malme, and D.H. Thomson, eds. Marine mammals and noise. San Diego: Academic Press.

Thomson, D.H., and R.A. Davis. 2001. *Review of the Potential Effects of Seismic Exploration on Marine Animals in the Beaufort Sea,* prepared by LGL Limited, for Fisheries and Oceans Canada, Yellowknife, Northern Territories, Canada. Available at http://www.czc06.ca/bsimpi/2001/REVIEW_OF_THE_POTENTIAL_EFFECTS_OF_SEISMIC_EXPLORATION_ON_M.pdf. Accessed Dec. 2, 2005.

Tyack, P.L. 1981. Interactions between singing Hawaiian humpback whales and conspecifics nearby. Behav. Ecol. Socbiol: 8:105-116.

Tyack, P.L. and C.W. Clark. 2000. Communication and Acoustic Behavior of Dolphins and Whales, Pages 156-224 *in* W. Au, A. N. Popper, and R. R. Fay, eds. Hearing in Whales and Dolphins. New York, Springer-Verlag.

Tyack, P.L. and H. Whitehead. 1983. Male competition in large groups of wintering humpback whales. Behavior 83:132-154.

University of Michigan Museum of Zoology (UMMZ) 2007a. Fin Whale (*Balaenoptera physalus*). Online at http://animaldiversity.ummz.umich.edu/site/accounts/information/Balaenoptera_physalus.html.

University of Michigan Museum of Zoology (UMMZ). 2007b. West Indian Manatee (*Trichechus manatus*). Online at http://animaldiversity.ummz.umich.edu/site/accounts/information/Trichechus_manatus.html.

U.S. Army Corps of Engineers. 2002. Environmental assessment and statement of findings, application no. 199902477, Cape Wind Associates, LLC. Available at: http://www.nae.usace.army.mil/projects/ma/ccwt/ea.pdf.

U.S. Dept. of Homeland Security. U.S. Coast Guard. 2003. Pollution incidents in and around U.S. waters a spill/release compendium: 1969–2004. Compliance Analysis Division, Washington, D.C. Available at: http://homeport.uscg.mil/mycg/portal/ep/home.do.

U.S. Dept. of the Interior. Minerals Management Serivice. 1999. Environmental Report, Use of Federal Offshore Sand Resources for Beach and Coastal Restoration in New jersey, Maryland, Delaware, and Virginia, OCS Study BOEMRE 1999-0036, November, 1999, Herndon, VA: USDOI/BOEMRE Headquarters.

U.S. Dept. of the Interior. Minerals Management Service. 2003. *OCS Environmental Assessment Revision to the Point Arguello Field Development and Production Plans to Include Development of the Eastern Half of Lease OCS-P 0451*. Available at http://www.mms.gov/omm/pacific/enviro/FEA/0451_FEA_body.pdf. Accessed July 2006.

U.S. Dept. of the Interior. Minerals Management Service. 2004. Geological and Geophysical Exploration for Mineral Resources on the Gulf of Mexico Outer Continental Shelf. MMS Gulf of Mexico OCS Region, New Orleans, LA. OCS EIS/EA MMS 2004-054. 487 pp.

U.S. Dept. of the Interior. Minerals Management Service. 2005. Structure-removal operations on the Gulf of Mexico Outer Continental Shelf: Programmatic environmental assessment. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS EIS/EA MMS 2005-013. 358 pp. Available at: http://www.gomr.mms.gov/PDFs/2005/2005-013.pdf.

U.S. Dept. of the Interior. Minerals Management Service. 2007a. Final Environmental Impact Statement, Outer Continental Shelf Oil and Gas Leasing Program: 2007-2012, OCS EIS/EA BOEMRE 2007-003, April 2007, Herndon, VA: USDOI/MMS Headquarters.

U.S. Department of the Interior, Minerals Management Service. 2007b. Programmatic Environmental Impact Statement for Alternative Energy Development and Production and Alternate Use of Facilities on the Outer Continental Shelf, Final Environmental Impact Statement, October 2007. OCS Report MMS 2007-046. Available at: http://www.ocsenergy.anl.gov/.

U.S. Dept. of the Interior, Minerals Management Service. 2008a. Cape Wind Energy Project—Draft Environmental Impact Statement. Volume I. U.S. Dept. of the Interior, Minerals Management Service, Headquarters, Herndon, VA. OCS EIS/EA MMS 2007-024. Available at: http://www.mms.gov/offshore/RenewableEnergy/DEIS/Volume%20I%20-%20Cape%20Wind%20DEIS/Cape%20Wind%20DEIS.pdf.

U.S. Dept. of the Interior, Minerals Management Service. 2008b. Biological Assessment for the Cape Wind Energy Project Nantucket Sound. U.S. Dept. of the Interior, Minerals Management Service, Headquarters, Herndon, VA. Available at: http://www.mms.gov/offshore/PDFs/May2008CapeWindFinalBA.pdf

U.S. Fish and Wildlife Service (USFWS). 2007a. West Indian Manatee (*Trichechus manatus*) 5-Year Review: Summary and Evaluation. Online at http://www.fws.gov/northflorida/Manatee/2007%205-yr%20Review/2007-Manatee-5-Year-Review-Final-color-signed.pdf

U.S. Fish and Wildlife Service (USFWS). 2008. Final Biological Opinion, Cape Wind Associates, LLC, Wind Energy Project, Nantucket Sound, Massachusetts Formal Consultation #08-F-0323. Available at: http://www.fws.gov/northeast/newenglandfieldoffice/pdfs/CapeWind-BO-21November2008_withCovLttr.pdf

U.S. Fish and Wildlife Service (USFWS). 2007b. Indiana Bat (*Myotis sodalis*) Draft Recovery Plan: First Revision. U.S. Fish and Wildlife Service, Fort Snelling, MN. 258 pp.

U.S. Fish and Wildlife Service (USFWS). 2006a. *USFWS Threatened and Endangered Species System, Endangered Species Program.* Available at http://ecos.fws.gov/tess_public/StateListing.do?state=all&status=candidate. Accessed Sept. 19, 2006.

U.S. Fish and Wildlife Service (USFWS). 2006b. Loggerhead Sea Turtle (*Caretta caretta*). Available at http://www.fws.gov/northflorida/SeaTurtles/Turtle%20Factsheets/loggerhead-sea-turtle.htm.

U.S. Fish and Wildlife Service (USFWS). 2006c. *Threatened and Endangered Species System (TESS) Database.* Available at http://ecos.fws.gov/tess_public/StartTESS.do. Accessed Sept. 13, 2006.

U.S. Fish and Wildlife Service (USFWS). 2005a. Green Sea Turtle (*Chelonia mydas*). North Florida Field Office. Online at http://www.fws.gov/northflorida/SeaTurtles/Turtle%20Factsheets/greensea-turtle.htm.

U.S. Fish and Wildlife Service (USFWS). 2005b. Leatherback Sea Turtle (*Dermochelys coriacea*). Online at http://www.fws.gov/northflorida/SeaTurtles/Turtle%20Factsheets/leatherback-seaturtle.htm.

U.S. Fish and Wildlife Service (USFWS). 2005c. Kemp's Ridley Sea Turtle (*Lepidochelys kempii*). Online at http://www.fws.gov/northflorida/SeaTurtles/Turtle%20Factsheets/kemps-ridley-seaturtle.htm.

U.S. Fish and Wildlife Service (USFWS). 2005d. Hawksbill Sea Turtle (*Eretmochelys imbricate*). Online at http://www.fws.gov/northflorida/SeaTurtles/Turtle%20Factsheets/hawksbill-seaturtle.htm.

U.S. Fish and Wildlife Service (USFWS). 2005f. West Indian Manatee (*Trichechus manatus*). Online at http://www.fws.gov/endangered/i/a/saa0c.html.

U.S. Fish and Wildlife Service (USFWS). 2002. Endangered and Threatened Wildlife and Plants; Manatee Protection Area in Florida. *Federal Register,* Vol. 67, No. 4, Jan. 7, *Rules and Regulations,* 50 CFR 17, RIN 1018-AH80: 680–696.

U.S. Fish and Wildlife Service (USFWS). 2001. Florida Manatee Recovery Plan, Third Revision. U.S. Fish and Wildlife Service Southeast Region, Atlanta, Georgia. 144 pp.

U.S. Fish and Wildlife Service (USFWS). 1999. South Florida Multi-Species Recovery Plan, Southeast Region, Atlanta, GA.

Vanderlaan, A. S., A. E. Hay, and C. T. Taggart. 2003. Characterization of North Atlantic Right-Whale (*Eubalaena glacialis*) Sounds in the Bay of Fundy. IEEE Journal of Oceanic Engineering 28:164-173.

Wahlberg, M. 2002. The acoustic behaviour of diving sperm whales observed with a hydrophone array. Journal of Experimental Marine Biology and Ecology 281:53-62.

Ward, J.A. 1999. Right whale (*Balaena glacialis*) South Atlantic Bight habitat characterization and prediction using remotely sensed oceanographic data. Master's thesis, University of Rhode Island.

Waring, G.T., C.P. Fairfield, C.M. Ruhsam, and M. Sano. 1993. Sperm whales associated with Gulf Stream features off the north-eastern USA shelf. Fisheries Oceanography 2(2):101-105.

Waring, G., D. Palka, P. Clapham, S. Swartz, M. Rossman, T. Cole, K. Bisack, and J. Hansen. 1998. U.S. Atlantic Marine Mammal Stock Assessments – 1998. National Marine Fisheries Service.

Waring, G., J. Quintal, and C. Fairfield (eds.). 2002. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2002. National Marine Fisheries Service.

Waring, G.T., R.M. Pace, J.M. Quintal, C.P. Fairfield, and K. Maze-Foley. 2004. U.S. Atlantic and Gulf of Mexico 2003 Marine Mammal Stock Assessments. Stock Assessment Report. Woods Hole, MA.

Waring, G., E. Josephson, C. Fairfield, and K. Maze-Foley (eds.). 2005. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2005. National Marine Fisheries Service.

Waring GT, Josephson E, Fairfield-Walsh CP, Maze-Foley K, editors. 2007. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments -- 2007. NOAA Tech Memo NMFS NE 205; 415 p.

Watkins, W.A. 1981. Activities and underwater sounds of fin whales. Sci. Rep. Whales Res. Inst. 33:83-117.

Watkins, W.A., M.A. Daher, A. Samuels, and D.P. Gannon. 1997. Observations of *Peponocephala electra*, the melon-headed whale, in the southeastern Caribbean. Carib. J. Sci. 33:34-40.

Watkins, W. A., K. E. Moore, and P. Tyack. 1985. Sperm Whale Acoustic Behaviors in the Southeast Caribbean. Cetology 49:1-15.

Watkins, W.A., P. Tyack, K.E. Moore, and J.E. Bird. 1987. The 20-Hz signals of finback whales (Balaenoptera physalus). JASA 82(6):1901-1912.

Watkins, W.A., and W.E. Scheville. 1975. "Sperm Whales React to Pingers," *Deep-Sea Research* 22:123–129.

Weilgart, L., and H. Whitehead. 1993. Coda communications by sperm whales (*Physeter macrocephalus*) off the Galapagos Islands. Can. J. Zool. 71:744-752.

Weilgart, L., and H. Whitehead. 1997. Group-Specific Dialects and Geographical Variation in Coda Repertoire in South Pacific Sperm Whales. Behavioral Ecology and Sociobiology 40:277-285.

Wenzel, F., D.K. Mattila, and P.J. Clapham. 1988. *Balaenoptera musculus* in the Gulf of Maine. Marine Mammal Science 4(2):172-175.

Wever, E.G. 1978. The Reptile Ear: Its Structure and Function. Princeton University Press, Princeton.

Whitehead, H. 2002. Sperm Whale, Pages 1165-1172 *in* W. F. Perrin, B. Wursig, and J. G. M. Thewissen, eds. Encyclopedia of Marine Mammals. San Diego, Academic Press.

Williams, K., R. Mies, D. Stokes, and L. Stokes. 2002. Stokes Beginner's Guide to Bats. New York: Little, Brown and Company.

Winn, H.E., J.D. Goodyear, R.D. Kenney, and R.O. Petricig. 1994. Dive patterns of tagged right whales in the Great South Channel. Cont. Shelf Res. 15:593-611.

Wishner, K., E. Durbin, A. Durbin, M. Macaulay, H. Winn, and R. Kenney. 1988. Copepod patches and right whales in the Great South Channel off New England. Bulletin of Marine Science 43(3):825- 844.

Witherington, B., R. Herren, and M. Bresette. 2006. *Caretta caretta* – Loggerhead Sea Turtle. Chelonian Research Monographs 3:74–89.

Withrow, D.E., et al. 1985. *Response of Dall's Porpoise* (Phocoenoides dalli) *to Survey Vessels in Both Offshore and Nearshore Waters: Results of 1984 Research*, Int. N. Pacif. Fish. Comm. Document, U.S. National Marine Mammal Laboratory, Seattle, WA.

Würsig, B., T.A. Jefferson, and D.J. Schmidley. 2000. The Marine Mammals of the Gulf of Mexico. Texas A&M University Press, College Station, TX. 232 pp.

Wursig, B., J. C.R. Greene, and T.A. Jefferson. 2000. Development of an air bubble curtain to reduce underwater noise of percussive pile driving. Marine Environmental Research 49:79-93. Available at http://www.sciencedirect.com/science/journal/01411136.

Wyneken, J. 1997. Sea turtle locomotion: Mechanisms, behavior, and energetics In: Lutz, P. and J. Musick (eds.). The biology of sea turtles. pp. 165-198. CRC Press, Inc., Boca Raton, FL.

Yochem, P.K. and S. Leatherwood. 1985. Blue whale *Balaenoptera musculus* (Linnaeus, 1758) In: Ridgway, S.H. and R. Harrison (eds.). Handbook of marine mammals Vol. 3: the sirenians and baleen whales. Academic Press. London, UK.

Zelick, R., D. Mann, and A. Popper. 1999. Acoustic communication in fishes and frogs, pp. 363-412. *In:* R. Fay and A. Popper (eds.), Comparative Hearing: Fish and Amphibians. Springer Handbook of Auditory Research, Vol. 11. Springer-Verlag, New York.

Zimmer, W.M.X., P.L. Tyack, M.P. Johnson, and P.T. Madsen. 2005. Three-dimensional beam pattern of regular sperm whale clicks confirms bent-horn hypothesis. J. Acoust. Soc. Am. 117 (3): 1473-1485.