Cape Wind Energy Project
Nantucket Sound

Biological Assessment

Minerals Management Service for Consultation with the United States Fish and Wildlife Service and NOAA Fisheries

May 2008

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1.0 BACKGROUND

This Biological Assessment (BA) was prepared in accordance with Section 7 of the Endangered Species Act (ESA) of 1973 (ESA, P.L. 93-205) which requires that all Federal agencies ensure that any action they authorize, fund or execute will not jeopardize the continued existence of any threatened or endangered species (i.e., listed species) or result in the destruction or adverse modification of any critical habitat of such species. The “action” under consideration is the construction, operation and maintenance, and decommissioning of an offshore wind energy project, proposed by Cape Wind Associates, LLC (the “Applicant” or “Cape Wind”). The proposed action consists of the installation and operation of 130 Wind Turbine Generators (WTGs) and associated equipment on Horseshoe Shoal in Nantucket Sound along with a submarine electric transmission cable system that connects the power to the mainland electrical grid.

The Department of the Interior, Minerals Management Service (MMS), as the federal agency authorizing the action, is required to consult on any action that may affect a listed species or designated critical habitat. As most of this proposed action will occur in federal waters, MMS is formally consulting with the Department of Commerce, NOAA Fisheries. Since there is a portion of the electrical cable that occurs on land, as well as the presence of several listed bird species, MMS is also formally consulting with the Department of the Interior, U.S. Fish & Wildlife Service (USFWS). A component of this consultation includes the preparation of this Biological Assessment (BA) to determine if the proposed actions are likely to result in adverse effects to threatened or endangered species. This BA covers those listed species that NOAA Fisheries and USFWS have identified as potentially occurring in the area of the proposed action or that could potentially be affected by the proposed action. The MMS will continue the consultation process with NOAA Fisheries and USFWS to ensure that the proposed action does not “…jeopardize the continued existence of threatened or endangered species or result in the destruction or adverse modification of the critical habitat of such species” (50 CFR Part 402).

Additional detailed information on the proposed action is contained in the DEIS, published in January 2008, which assesses the physical, biological and social/human impacts of this proposed action and all reasonable alternatives, including no action, in an objective fashion in order to determine if the proposed action is environmentally sound. Much of the information presented in the DEIS was derived from studies and information provided by the applicant in its application materials, and as relevant and pertinent, this and additional information were used to compile the information for this BA.

1.1 Project History

The New England region is heavily dependent on natural gas to meet its increasing demand for energy. In New England natural gas accounts for 18 percent of the region’s total energy consumption, approximately 40 percent of the fuel used to generate electricity, and its consumption is expected to increase 31.6 percent by 2024 (2005, The Power Planning Committee of the New England Governor’s Conference). In addition, more than 9,000 MW of planned gas-fired power plants are considered likely to be built in New York, Ontario, and Quebec, which will in turn compete with New England’s limited gas supply and delivery infrastructure. The New England region's independent system operator (ISO-NE) has stated that over-reliance on natural gas subjects the New England region to substantial price fluctuations that are influenced by a variety of market-based factors (i.e., exercising of natural gas contractual rights, tight gas spot-market trading), and physical factors (i.e., pipeline maintenance requirements and limited pipeline capacity). Over-reliance on natural gas and other fossil fuel sources (e.g., coal) for the generation of electricity also subjects the region to adverse air quality impacts associated with ground level ozone. There is, therefore, a need for electric generation projects in New England that aid in diversifying the region's energy mix in a manner that does not significantly contribute to the region's existing air quality concerns.

The need also arises from the Massachusetts and regional RPS, which mandate that a certain amount of electricity come from renewable energy sources, such as wind. Specifically, the Massachusetts RPS requires that all retail electricity providers in the state utilize new renewable energy sources for at least 2.5 percent of their power supply in 2006, increasing to 4 percent by 2009 (http://www.mass.gov/doer/rps/regs.htm). Since 1995, the Massachusetts Energy Facilities Siting Board (EFSB) has authorized more than a dozen fossil fueled power plants with nominal generating capacities that range from approximately 200 MW to 1500 MW, with an average of approximately 500 MW. This proposed action seeks to construct a similar large size "commercial" scale project in order to address a substantial portion of the projected Massachusetts 2009 RPS requirements[1], while also providing the volumes needed to respond to the magnitude of the regional reliability requirements.[2]

The NEPOOL operates as a tightly integrated system for purposes of both dispatch and compliance with reliability standards, including standards as to adequacy of generation resources. ISO New England's 2005 Regional System Plan for NEPOOL (RSP05) considered the constraints upon potential energy imports into NEPOOL and found that "the need for operable capacity resources internal to New England will be required earlier than the 2009 through 2013 timeframe..." Notably, the ISO also found that "in the real-time operating environment, transmission interface operating limits change constantly" and that "[t]he projected capacity situation for the neighboring . . . control areas coupled with the transmission limitations shows that New England should not rely heavily on neighboring systems for capacity during periods of peak load, especially during the latter part of the planning period."

Based on these needs, Cape Wind began preliminary work on siting and designing a wind energy project in 2000, and has continued to advance the design and perform studies and data collection to the present time. Currently Cape Wind has requested a lease, easement, right-of-way (ROW) and any other related approvals from MMS necessary to authorize construction, operation, and decommissioning of the proposed action. MMS's authority to approve, deny, or modify the Cape Wind Energy Project derives from the Energy Policy Act of 2005

[1] Based on the Average Wind Speed of 19.75 mph (8.8 m/s), the net annual energy production the Project will deliver to the regional transmission grid will be 1,600 GWh, which would be approximately 75 percent of the 2009 projected renewable portfolio standard requirement of 2,100 GWh (2004, MA RPS Annual Compliance Report).

[2] NEISO conducted a system wide analysis of energy demand and concluded that New England needs approximately 170 MW of additional electricity production resources before the summer of 2010 and increasing annually to 2100 MWs of additional capacity by 2014 to meet New England's electricity reliability requirements (ISO Regional System Plan, 2005).

(http://www.mms.gov/2005EnergyPolicyAct.htm#Renewables). Section 388 of the Act authorizes the Department of the Interior (DOI) to grant leases, easements or ROWs on OCS lands for activities that produce or support production, transportation, or transmission of energy from sources other than oil and gas, such as wind power.

1.2 Federal Consultation Action History

In November 2001, Cape Wind sought permission from the U.S. Army Corps of Engineers (ACOE) to construct and operate a wind-powered electrical generating facility on Horseshoe Shoal in Nantucket Sound, Massachusetts. A Draft EIS was ultimately published by the ACOE, including a BA dated May 2004. In August 2005, the Energy Policy Act of 2005 was passed which gave the Department of the Interior, Minerals Management Service authority for issuing leases, easements, or rights-of-way for alternative energy projects on the Outer Continental Shelf (OCS) and purview over the Cape Wind proposal was transferred from the ACOE to MMS. MMS then determined that a new DEIS was required given its different federal approval processes and requirements. The MMS DEIS for the Cape Wind proposal was published in January 2008 and is included as further detail as part of the ESA consultation package. On March 29, 2007, the applicant also obtained a certificate from the Commonwealth of Massachusetts under the Massachusetts Environmental Policy Act certifying the adequacy of the environmental review portions of the proposed action occurring within State waters.

MMS has been informally consulting with NOAA Fisheries since January 2006. This has included one conference call on January 23, 2006 with a representative from the NOAA Fisheries Northeast Regional Office to discuss the proposed action and any impact concerns associated with ESA-listed species under NOAA Fisheries jurisdiction. In addition, MMS has also communicated by email with NOAA Fisheries as recently as November 2007 to gather more information on mitigation and monitoring measures related to pile driving activities. NOAA Fisheries and the USFWS were also provided a draft BA in December 2007 for review and comment. In addition, NOAA Fisheries included information on its ESA-listed species in its July 26, 2006 response letter to MMS's Notice of Intent to prepare an EIS for the proposed action. The NOAA Fisheries originally provided MMS with a species list on April 20, 2007 and confirmed this list by email on October 18, 2007.

MMS has also been informally consulting with the USFWS since January 2006. These efforts have included approximately 10 conference calls and two face-to-face workshops aimed at discussing potential impacts from the proposed action, avian collision risk modeling and population viability assessments, research needs and identification of areas of uncertainty over project impacts, and project mitigation and monitoring measures for ESA-listed species under USFWS purview. On January 5, 2007, the USFWS provided a species list to the applicant (via the applicant's contractor ESS Group, Inc.) regarding ESA-listed species found in the proposed action area along the submarine cable in Nantucket Sound and the upland cable NSTAR transmission line corridor in Yarmouth, MA. MMS requested its own concurrence with the USFWS for ESA-listed species over the entire action area on October 9, 2007. The USFWS provided its responding species list on November 16, 2007. The USFWS and NOAA Fisheries were provided a draft BA in December 2007 for review and comment.

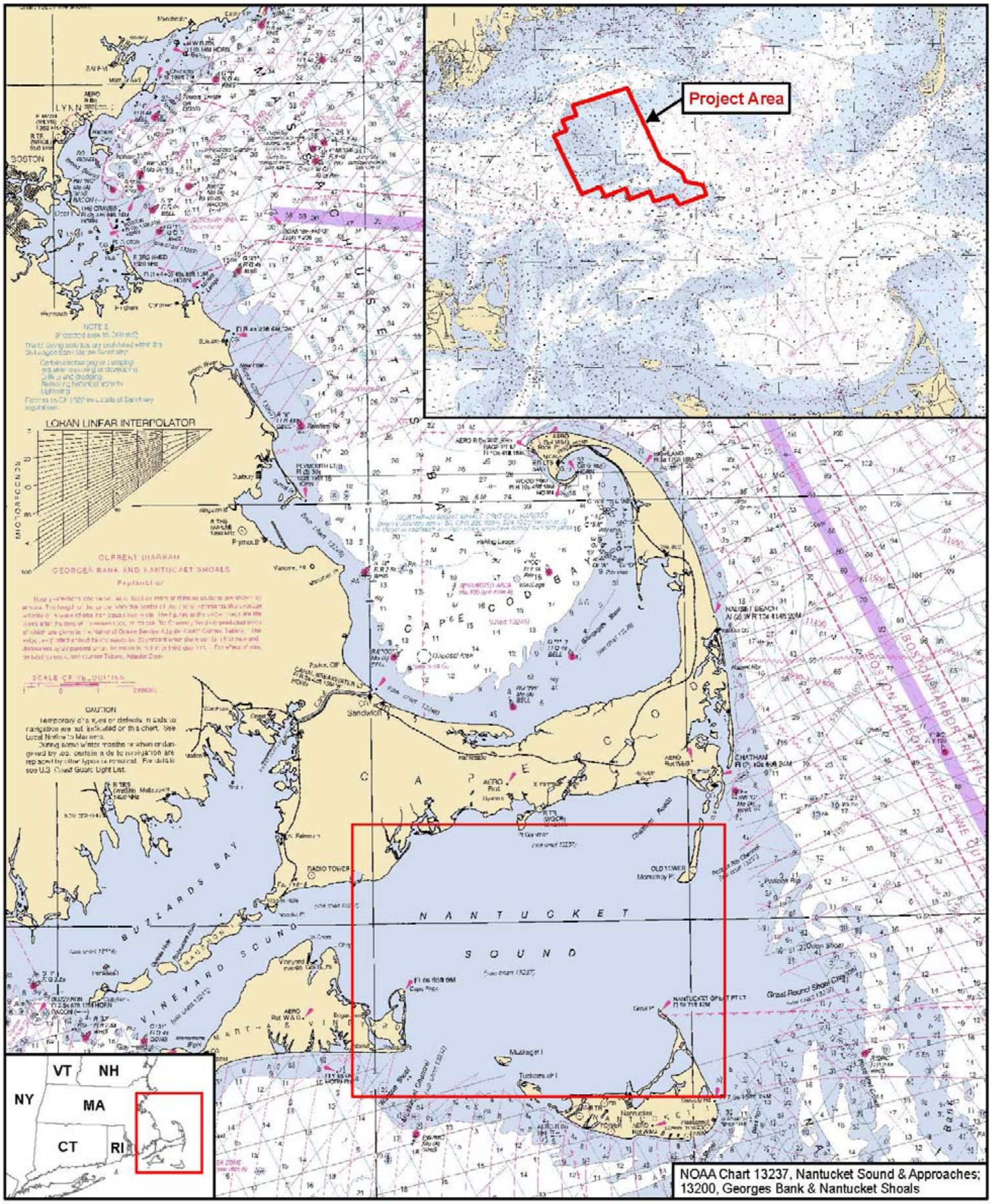
2.0 DESCRIPTION OF THE ACTION AND ACTION AREA

The proposed action entails the construction of a Wind Park consisting of 130 wind turbine generators (WTG) located on Horseshoe Shoal in Nantucket Sound, Massachusetts (Figure BA-1). Each of the 130 WTGs will generate electricity independently of each other. Within the nacelle of each turbine, a wind-driven generator will produce low voltage electricity, which will be "stepped up" by an adjacent transformer to produce 33 kilovolts (kV) electric transmission capacity of the WTG. Solid dielectric submarine cables from each WTG will interconnect within the grid and terminate at their spread junctions on the electrical service platform (ESP). The ESP will serve as the common interconnection point for all of the WTGs within the Wind Park. The proposed submarine cable system is approximately 12.5 miles (20.1 km) in length (7.6 mile (12.2 km) within the Massachusetts 3-nautical mile (5.5 km) territorial line) from the ESP to the landfall location in Yarmouth. The submarine transmission cables would travel north to northeast in Nantucket Sound into Lewis Bay past the westerly side of Egg Island, and then make landfall at New Hampshire Avenue. The proposed onshore transmission cable route to its intersection with the NSTAR Electric ROW would be located entirely along existing paved ROWs where other underground utilities already exist. All of the roadways within Yarmouth and Barnstable in which the proposed transmission cable would be placed are town owned and maintained roads with the exception of Routes 6 and 28, which are owned and maintained by Massachusetts Highway Department (MHD). A portion of the onshore transmission cable route would also be located underground within the existing maintained NSTAR Electric ROW.

Each WTG has an energy generating capacity of 3.6 megawatts (MW) ± and the proposed action is designed for a maximum electrical energy capacity of 468 MW. Based on the average wind speed in Nantucket Sound of 19.75 mph (8.8 m/s), facility will have an average generation capacity of 182.6 MW, and the net energy production delivered to the regional transmission grid will be approximately 1,600 GW hours/year. In order to generate maximum wind energy production, the WTGs will be arranged in specific parallel rows in a grid pattern. For this area of Nantucket Sound, the wind power density analysis conducted by the applicant determined that orientation of the array in a northwest to southeast alignment provides optimal wind energy potential for the WTGs. This alignment will position the WTGs perpendicular to prevailing winds, which are generally from the northwest in the winter and from the southwest in the summer for this geographic area in Nantucket Sound.

The WTGs have a stated design life span of twenty years. However, this estimate is based on experience generated from land-based machines which are subject to higher levels of turbulence and arguably experience greater wear and tear than can be expected offshore where winds are less turbulent. It is possible that the proposed action could be operational beyond the minimum design life of twenty years.

The anticipated schedule for the entire proposed action, assuming all Federal and state permitting and approval processes are completed in the fourth quarter of 2008, is as follows: (1) during the winter of 2009-2010 the onshore ductbanks, landfall transition and the temporary cofferdam will be installed; (2) during the third and fourth quarter of 2009 and first quarter of



CAPE WIND ENERGY PROJECT

Figure BA-1
Project Locus Map

2010 the ESP, the submarine 115 kV cables, and the onshore 115 kV cables will be installed; and (3) beginning the first quarter of 2010, the WTGs, the inner-array cables and the scour mats will be erected and installed. The anticipated schedule for the permitting of the proposed action and its construction is provided in Figure 2.3.1-1 of the DEIS.

2.1 Wind Turbines

Each turbine is pitch-regulated with active yaw to allow it to turn into the wind, and has a three-blade rotor. The main components of the Wind Turbine Generator (WTG) are the rotor, transmission system, generator, yaw system, and the control and electrical systems, which are located within the nacelle. The nacelle is the portion of the WTG that encompasses the drive train and supporting electromotive generating systems that produce the wind-generated energy. The WTGs nacelle would be mounted on a manufactured tubular conical steel tower with triple paint system supports supported by a monopile foundation system. A pre-fabricated access platform and service vessel landing (approximately 32 ft [9.75 m] from mean lower low water (MLLW)) would be provided at the base of the tower. The rotor has three blades manufactured from fiberglass-reinforced epoxy, mounted on the hub. The monopiles within the area of the proposed action would utilize two different diameter foundation types depending on water depth. Water depths of 0 to 40 ft (0 to 12.2 m) would utilize a 16.75 ft (5.1 m) diameter monopile and water depths of approximately 40 to 50 feet (12.2 to 15.25 m) would utilize an 18.0 ft (5.5 m) diameter monopile.

Each WTG has an energy generating capacity of 3.6 megawatts (MW) ± and the proposed action is designed for a maximum delivered electrical energy capacity of 454 MW. The generating capacity is based on the design wind velocity of 30 mph (13.4 m/s) and greater, up to the maximum operational velocity of 55 mph (24.6 m/s). Based on the average wind speed in Nantucket Sound of 19.75 mph (8.8 m/s), facility would have an average generation capacity of 182.6 MW, and the net energy production delivered to the regional transmission grid would be approximately 1,600 GW hours/year.

In order to generate maximum wind energy production, the WTGs would be arranged in specific parallel rows in a grid pattern. For this area of Nantucket Sound, the wind power density analysis conducted by the applicant determined that orientation of the array in a northwest to southeast alignment provides optimal wind energy potential for the WTGs. This alignment would position the WTGs perpendicular to prevailing winds, which are generally from the northwest in the winter and from the southwest in the summer for this geographic area in Nantucket Sound. The WTGs would have a computer-controlled yaw system that ensures that the nacelle is always turned into the wind and perpendicular to the rotor. In addition to maximizing potential wind energy production, the WTGs must also be sufficiently spaced within the array in order to minimize power losses due to wind shear and turbulence caused by other WTGs within the array. The optimal WTG spacing within the array is 0.34 nautical mile (629 meters) by 0.54 nautical mile (1,000 meters) between each WTG.

The Wind Park would consist of 130 WTGs located on Horseshoe Shoal in Nantucket Sound, Massachusetts. The northernmost WTGs would be approximately 3.8 miles (6.1 km) from the dry rock feature (offshore near Bishop and Clerks) and approximately 5.2 miles (8.4 km) from

Point Gammon on the mainland; the southernmost part of the Wind Park would be approximately 11 miles (17.7 km) from Nantucket Island (Great Point), and the westernmost WTG would be approximately 5.5 miles (8.9 km) from the island of Martha's Vineyard (Cape Poge). The proposed action's leasehold area as presented in the Cape Wind Leasehold Application submitted to MMS on September 14, 2005, includes an expanded perimeter around the area of the proposed action in order to ensure that a sufficient buffer exists between the area of the proposed action and any other subsequent leases by MMS that could impact the ability of the proposed action to produce power at the anticipated level.

The water depths within Nantucket Sound range from 1 to 70 ft (0.3 to 21.3 m) at mean lower low water (MLLW). Depths on Horseshoe Shoal range from as shallow as 0.5 ft (0.15 m) to 60 ft (18.3 m) at MLLW. Along the cable interconnection corridor, between Horseshoe Shoal and the Cape Cod shoreline, water depths vary from 16 to 40 ft (4.9 to 12.2 m) at MLLW, with an average depth of approximately 30 ft (9.1 m) at MLLW. Water depths within Lewis Bay and Hyannis Harbor range from 8 to 16 ft (2.4 to 4.9 m) at MLLW in the center of the bay to less than 5 ft (1.5 m) at MLLW along the perimeter and between Dunbar Point and Great Island.

2.2 Inner Array Cables

Each of the 130 WTGs within the Wind Park would generate electricity independently of each other. Within the nacelle of each turbine, a wind-driven generator would produce low voltage electricity, which would be "stepped up" by an adjacent transformer to produce 33 kV electric transmission capacity of the WTG. Solid dielectric submarine cables from each WTG would interconnect within the grid and terminate at their spread junctions on the electrical service platform (ESP).

2.3 Electrical Service Platform

An ESP would be required to be installed and maintained within the approximate center of the WTG array. It would serve as the common interconnection point for all of the WTGs within the Wind Park. Each WTG would interconnect with the ESP via a 33 kV submarine cable system. These cable systems would interconnect with circuit breakers and transformers located on the ESP in order to transmit wind-generated power through the 115 kV shore-connected submarine cable systems. The ESP would provide electrical protection and inner-array cable sectionalizing capability in the form of circuit breakers. It would also include voltage step-up transformers to step the 33 kV inner-array transmission voltage up to the 115 kV voltage level of the submarine cable connection to the land-based system. The ESP would have a helipad to allow personnel access when conditions preclude vessel transport, and for emergency evacuation.

The ESP would be a fixed template type platform consisting of a jacket frame with six 42-inch (1.1 m) driven piles to anchor the platform to the ocean floor. The platform would consist of a steel superstructure of approximately 100 ft by 200 ft (30.5 m by 61 m). The platform would be placed approximately 39 ft (11.9 m) above the MLLW datum plane in 28 ft (8.5 m) of water.

The submarine cable system interconnecting the WTGs with the ESP would be of solid dielectric AC construction, using a three-conductor cable with all phases under a common jacket. The cables would be arranged in strings, each of which would connect up to approximately 10 WTGs to a 33 kV circuit breaker on the ESP. There would be a total of approximately 66.7 mile (107 km) of inner-array cabling throughout the Wind Park.

The proposed submarine cable system is approximately 12.5 mile (20.1 km) in length (7.6 miles (12.2 km) within the Massachusetts 3-mile (5.5 km) territorial line) from the ESP to the landfall location in Yarmouth. The submarine transmission cables would travel north to northeast in Nantucket Sound into Lewis Bay past the westerly side of Egg Island, and then make landfall at New Hampshire Avenue.

Each of the two circuits consists of two (2) three-conductor cables, resulting in a total of four (4) cables. The four, three-conductor cables offer several other advantages including integral fiber optic cables and increased reliability in the case of an internal fault in one cable, where more than 75 percent of the total power available could still be delivered while the faulted cable is awaiting repair. The four submarine transmission cables would be installed as two circuits by bundling two cables per circuit together during installation and installing the two circuits. The conductor cross section is 3 x 1.24 sq in (800 mm^2) and the overall diameter of the cable is 7.75 in (197 mm). The submarine transmission cables would transition to the onshore transmission cable by using horizontal directional drilling (HDD) methodologies to a transition vault positioned at the end of New Hampshire Avenue.

The onshore cables would be jointed to the submarine cables at the landfall in Yarmouth. The onshore transmission cable system would utilize 12 single-conductor 115 kV cables. The cables would run in a concrete encased duct bank. The conductor cross bank would be 1.24 sq in (800 mm^2).

2.4 Staging Areas

Cape Wind has indicated that Quonset Point, Rhode Island may be the primary staging areas for the construction of the proposed action. During construction and operation phases, large equipment, components, and supplies would most likely be staged out of Quonset Point whereas during the operational phase, typical supplies and equipment, as well as the maintenance vessels may be staged out of New Bedford and/or Falmouth. The use of these staging areas requires that numerous roundtrip vessel transits occur during all phases of the proposed action.

2.5 Project Activities and Operations

2.5.1 Installation

Installation of the WTGs will comprise four activities:

1) installation of the foundation monopiles;
2) erection of the wind turbine generator;
3) installation of the inner-array cables; and
4) installation of the scour protection.

The ESP design is based on a piled jacket/template design with a superstructure mounting on top. The platform jacket and superstructure will be fully fabricated on shore and delivered to the work site by barges, where it will be installed. The proposed method of installation of the submarine cable is by the Hydroplow embedment process, commonly referred to as jet plowing. This method involves the use of a positioned cable barge and a towed hydraulically-powered jet plow device that simultaneously lays and embeds the submarine cable in one continuous trench from WTG to WTG and then to the ESP. The transition of the interconnecting 115 kV submarine transmission cables from water to land will be accomplished through the use of HDD methodology in order to minimize disturbance within the intertidal zone and near shore area.

2.5.2 Operation

It is anticipated that the main operation center for the Cape Wind Offshore farm would be located in the Town of Yarmouth. Here would be installed the remote monitoring and command center where all decisions concerning the operation of the marine generating facility would be made. These operational decisions would also include any instructions received either manually or automatically from the operator of the regional electrical power grid (IS0 New England). It is also to this center that all commands, instructions or requests would be received from marine and aviation bodies such as the USCG and the Federal Aviation Administration (FAA).

The service and maintenance personnel would be stationed at one of two additional onshore locations: one for the parts storage and larger maintenance supply vessels and the second located closer to the site for crew transport. The maintenance operation would likely be based in New Bedford, Massachusetts and may also deploy several crew boats out of Falmouth, Massachusetts.

A New Bedford facility would likely be located on Popes Island and would include dock space for two 65 ft (19.8 m) maintenance vessels, as well as a warehouse for parts and tool storage, and crew parking. An off-site warehouse would also be utilized to increase parts storage. The maintenance facility would house tools, spare parts and maintenance materials and would be organized to support daily work assignments. These would be loaded into small containers, assigned to each of the work teams and loaded onto the maintenance vessel for deployment to the wind farm site. The maintenance vessel would then go to either the WTG or the ESP and offload the containers for the work crews.

Additional dock space would likely be rented in Falmouth Inner Harbor from which work crews would be deployed to either the WTG and/or the ESP in 35 and 45 ft (10.7 and 13.7 m) crew boats manned by professional mariners. In addition, a high-speed emergency response boat (20 to 25 ft [6.1 to 7.6 m] boat) would be maintained at this harbor ready to respond whenever there is marine activity taking place.

The Control & Monitoring center in Yarmouth would maintain a 24/7 telecommunication protocol with all members of the operation both at management level as well as the engineers. As is normal with such operations a roster system is in place whereby designated personnel are on emergency call-out during the night, weekends and holidays. Night and holiday watch staff at the center would normally be restricted to two persons.

2.5.2.1 Service

To the extent possible, routine servicing of the WTGs would be scheduled to take place during the summer months when sea states are more conducive to daily maritime operations. Other weather windows (approximately 3 days duration for maintenance of a single WTG) may be used throughout the year in order to minimize wear and tear and the potential for excessive equipment breakdown or parts replacement.

If a WTG required this level of repair, a longer period of low wave heights and suitable weather conditions would be required in order to allow access and suitable working conditions. The duration necessary to complete a repair would be determined and the next available opportunity would be capitalized upon to complete the repair. Given the typically more suitable conditions during summer months, more repairs may occur during summer than winter months.

Planned Preventative Service and Maintenance of a WTG could include:

- Testing of fog horns;
- Cleaning of the machine rooms;
- Changing of carbon brushes;
- Changing of filters for air and all liquids as necessary;
- Topping up of all fluids;
- Replacement of defective instruments;
- Change-out of calibrated anemometers;
- Cleaning of lenses;
- Recharging of auto-grease systems;
- Appropriate local measurements;
- Control of dehumidifiers;
- Torquing of bolts;
- Replacement of brake pads;
- Control / replacement of hazard warning lights; and
- Heavy duty electrical connections.

Routine service, excluding the 100 percent bolt torquing and major oil change is usually a two day exercise for 3 to 4 persons. Such a 3 to 4 man crew would normally consist of a High Voltage Electrical technician, an Electronics/Instrumentation technician, a Mechanical technician, and a general helper.

All personnel would be trained in maritime operations and survival including emergency evacuation of the turbine nacelle. Every operative is equipped with a life jacket and survival suit. Provisions for emergency stays are provided in the event that conditions occur suddenly which precludes offloading of maintenance personnel.

Servicing of the offshore ESP would be conducted by the crew of a specialist sub-contractor trained in the service and maintenance of HV equipment. The platform would be similarly equipped with survival equipment and rations to be used in the event of weather prevented egress. As this structure would include a helicopter landing platform, emergency evacuation can be affected by direct conveyance onto the aircraft rather than via a hoist cable.

2.5.2.2 Maintenance

Unplanned maintenance is carried out to any part of the WTG in response to a breakdown or failure. Such activity may be simple and requiring only hand tools, in which case the normal crew vessels would suffice. If there is a requirement to exchange larger items - though not major - use of the 65 foot maintenance vessel would be required to transport and lift the particular items. Such items of equipment could be an electrical control cabinet, and 33 kV voltage transformer, generator, gearbox parts, *etc.*

The ability to conduct such operations would depend heavily on the prevailing weather conditions. It is unlikely that such repairs could be carried out where significant wave heights exceed 5 ft (1.5 m). Accurate and intelligent weather forecasting is an essential ingredient in the planning of such offshore operations where a weather window of 1 to 3 days is required to complete the task.

2.5.2.3 ESP Service

The ESP would have a helicopter-landing platform in addition to the boat dock. This would allow for maintenance crews to be deployed to the ESP during periods when wind and wave conditions are unsuitable for boat transfers. The helicopter platform would also allow for emergency evacuation of any individuals who may become injured.

2.5.2.4 Submarine Cable Repair

The potential for a fault occurring during the operational lifetime of a buried cable system is minimal, based on industry experience. However, a cable repair plan would be formulated to cover the remote possibility of a fault occurring in the offshore submarine cable system. The focus would be to repair the cable quickly while minimizing or eliminating environmental and community impacts.

Should a cable failure occur, a mobilization and communication plan would be implemented. Once the location of the fault is identified, should the cable fault occur in the onshore sections of the proposed action, then the cable would be repaired from the nearest manhole. Within the submarine portion of the proposed action, specific procedures detailed in Section 2.4.6 of the DEIS may be used for repairing a cable fault. Communication with the appropriate people would take place at least 48 hours prior to repair and would include location, method, and date of work.

2.5.3 Decommissioning Methodology

In the event that the proposed action ceases operation, a decommissioning plan would be implemented to remove and recycle, to the greatest degree possible, equipment and associated materials, thereby returning the area essentially to pre-existing conditions, to the extent practicable.

Any decision by the proposed action's owners to cease operation of individual WTGs or the entire proposed action and to decommission and remove the proposed action's components would require consultation with MMS. MMS would then consult with the FWS and NOAA Fisheries to determine if reinitiation of consultation was required based on any decommissioning plans. If the entire proposed action ceases to operate for a period of time of 18 months or more, and during that time the proposed action's owners have made no good-faith effort to restart operation, upgrading or decommissioning, the proposed action may be determined to be inoperative and decommissioning instruments may be accessed by MMS to initiate decommissioning activities. An appropriate procedure would be developed to give notice to the proposed action's lenders with the opportunity to cure any default before the proposed action is dismantled. Decommissioning the proposed action is largely the reverse of the installation process (Refer to Section 2.5 of the DEIS, for additional details).

It is anticipated that equipment and vessels similar to those used during installation, would be utilized during decommissioning. For offshore work this would likely include a jet plow, crane barges, jack-up barges, tugs, crew boats and specialty vessels such as cable laying vessels or possibly a vessel specifically built for erecting WTG structures. For onshore work, traditional construction equipment such as backhoes and cable trucks would be utilized. The environmental impacts from the use of this equipment during decommissioning activities would be similar, although not identical, to impacts experienced during construction.

The decommissioning of the offshore facilities would necessitate the involvement of an onshore disposal and recycling facility with the capacity and capabilities of handling the large quantities of steel, fiberglass and other materials from the proposed action. Acknowledging the fact that other potential onshore disposal and recycling facilities may exist 20 years from now that may prove to be more desirable, facilities do currently exist that are capable of handling the materials. Prolerized New England Inc. (Prolerized) operates several facilities, two which are located in Everett Massachusetts, and Johnston Rhode Island. Discussions with Prolerized staff indicate that they have the capabilities and capacity to handle the disposal and recycling of the proposed action if it were to take place today. The Everett facility has deep water access, allowing for the steel towers and monopiles to be directly offloaded from the barges, cut into manageable sections, sheared into smaller pieces and then shipped to end-users as scrap metal. For this reason the Everett facility would be the preferred location for the onshore disposal and recycling of the proposed action's materials. Currently there is no commercial scrap value for the fiberglass in the rotor blades. The fiberglass from the blades would be cut into manageable pieces and then disposed of as solid waste at an approved onshore facility.

3.0 SPECIES AND CRITICAL HABITAT DESCRIPTION

The latest species list received from NOAA Fisheries (dated 4/20/07 and reconfirmed on 10/18/07) indicates there are three species of whales and four species of sea turtles that have the potential to occur in the Project Area and may be adversely affected by the proposed action (See Table 1). Critical habitat has been designated for the North Atlantic Right whale in southeastern Massachusetts, but outside of Nantucket Sound. The designated critical habitats are located within Cape Cod Bay and along the Great South Channel. These areas do not overlap with the proposed Action area. In addition, NOAA Fisheries species list also identifies the presence of sei (*Balaenoptera borealis*) and sperm whales (*Physter macrocephalus*) as seasonally present in New England waters but generally found in deeper offshore waters. As such, MMS has determined that the proposed action is not likely to affect these two whale species and they are not considered further in this BA. Given that fin whales have been sighted in some areas identified as the preferred or alternative sites of the DEIS, MMS has included them in this BA for further consideration.

The latest species list received from the USFWS (dated 11/16/07) indicates that there are two listed species of birds and two candidate species (red knot and New England cottontail) that have the potential to occur in the area and may be adversely affected by the proposed action. There is no critical habitat designated in the proposed action or surrounding area for these species.

As required under Section 7 of the ESA, MMS is requesting consultation on listed species but not on candidate species. However, additional consideration of any candidate species, including the potential for impacts and any needed mitigation, can be found in the MMS EIS for the Cape Wind proposal as it further develops.

Table 1 below lists the species that are addressed in this BA and for which MMS is requesting formal consultation. Species descriptions are summarized below, while potential impacts from the proposed action are discussed in Section 5.

Table 1.
Listed Species Requested for Consultation

Group	Common Name	Scientific Name	Status	Critical Habitat
Whales	Humpback Whale	*Megaptera novaeangliae*	E	No
	North Atlantic Right Whale	*Eubalaena glacialis*	E	Yes
	Fin Whale	*Balaenoptera physalus*	E	No
Sea Turtle	Kemp's ridley	*Lepidochelys kempii*	E	No
	Leatherback	*Dermochelys coriacea*	E	No
	Loggerhead	*Caretta caretta*	T	No
	Green	*Chelonia mydas*	T	No
Avian	Roseate Tern	*Sterna dougallii*	E	No
	Piping Plover	*Charadrius melodus*	T	No

3.1 Whales

3.1.1 Humpback Whale

3.1.1.1 Species Description

Humpback whales (*Megaptera novaeangliae*) occur in all the oceans of the world, often in areas of upwelling, along the edges of banks, and over rapidly changing bathymetry along the continental shelf, and along frontal zones between well-mixed and stratified water masses (Waring *et al.,* 2006). The fifth largest of the baleen whales, humpback whales are approximately 13 ft (4 m) long at birth and reach a maximum size of 59 ft (18 m) and a weight of 106,000 lbs (48,080 kg) (Winn and Reichley, 1985). Females are slightly larger than males. Distinguishable features of humpback whales include extremely long flippers that may reach 16.4 ft (5 m) in length, well-defined ventral grooves and fleshy protuberances (tubercles) that cover the whale's rostrum and a small, variable shaped dorsal fin. Color patterns are used to identify individuals, specifically by the black and white patterns on the underside of the fluke and pectoral fins (Katona *et. al.,* 1980; Katona and Whitehead, 1981). Calves also appear to inherit the fluke pigmentation patterns of their mothers (Rosenbaum and Clapham, 1993).

3.1.1.2 Life History

Female humpback whales reach sexual maturity after four to six years and thereafter give birth approximately every two or three years (Waring *et al*., 2006; Clapham, 1992). The gestation period is ten to twelve months and most births take place in the winter in the West Indies (Waring *et al*., 2006). Mothers usually nurse their calves for a year or less, as weaning may begin when the calves are five to six months old and still in the northern feeding grounds (Clapham, 1992; Baraff and Weinrich, 1993; Waring *et al*., 2006). After weaning their calves, the adult females are ready to mate again. The life span of humpback whales is approximately 30 years (Chittleborough, 1959).

Humpback whales are migratory species that spend winter breeding in the Lesser and Greater Antilles Islands of the eastern Caribbean Sea (Waring *et al.,* 2006). Summers are spent in northern latitude feeding grounds (40° to 75° N latitude) in areas of high productivity off the coasts of Iceland, southwestern Greenland, Newfoundland and Labrador, the Gulf of St. Lawrence, and the Gulf of Maine (Waring *et al.,* 2006). Movements of humpbacks within the northern latitude feeding grounds are controlled by prey densities favoring areas of upwelling on the shelf supporting dense aggregations of near-surface zooplankton and shoaling, plankton-feeding fish upon which the whales feed (Brodie *et al*., 1978; Gaskin, 1982; Kenney and Winn, 1986; Dolphin, 1987a, b; Mayo *et al*., 1988; Waring *et al*., 2006).

Humpback whales feed opportunistically on a wide variety of species of pelagic crustaceans and small fish including sand lance (*Ammodytes americanus* and *A. dubius)*, capelin (*Mallotus villosus*), and euphausiids (*Meganyctophanes norvegica*) (Nemoto, 1970; Hain *et al*., 1982; Kreiger and Wing, 1984; Whitehead and Glass, 1985; Waring *et al*., 2006). During their seasonal northern residency in the area, humpbacks may also feed on several commercially important fish and invertebrates, such as herring (*Clupea harengus*), mackerel (*Scomber* *scombrus*), menhaden (*Brevoortia tyrannus*), pollock (*Pollachius virens*), small haddock (*Melanogrammus aeglfinus*), and squid (*Illex illecebrosus*) (Overholtz and Nicolas, 1979; Meyer *et al.,* 1979; Whitehead and Glass, 1985; Whitehead, 1987; Piatt *et al*., 1989; Waring *et al*., 2006). They may feed singly or in closely coordinated groups. Groups of up to 22 individuals may lunge in unison at surface schools of fish (Hain *et al*., 1982; Würsig, 1990).

3.1.1.3 Population Dynamics

As reported in the 2006 Marine Mammal Stock Assessment Report (Waring *et al*., 2007), 902 whales is considered the best abundance estimate for humpbacks in the Gulf of Maine, with a minimum population estimate of 647 individuals. Currently the best available estimate of the North Atlantic population is 11,570 (coefficient of variation (CV) = 0.068) individuals based on mark and recapture studies in 1992 and 1993 (Waring *et al*., 2007).

Western North Atlantic humpbacks belong to four primary feeding aggregations: United States east coast (including the Gulf of Maine), the Gulf of St. Lawrence, Newfoundland/Labrador, and western Greenland (Waring *et al*., 2006). Two other North Atlantic feeding grounds have been identified off Iceland and northern Norway (Waring *et al*., 2006). Composition of these feeding aggregations is determined by matrilineal fidelity. Based on genetic evidence supporting the distinction of the western North Atlantic feeding, the Gulf of Maine is now viewed as a distinct feeding stock for management purposes (Waring *et al*., 2006). Humpbacks from these three feeding aggregations seem to congregate preferentially in winter breeding and calving areas off the Dominican Republic and eastern Puerto Rico (Waring *et al*., 2006) and may follow similar southward migration routes from summer feeding areas to winter breeding areas.

Little is known about natural mortality in humpback whales. Parasites, toxics, ice entrapment, predation by killer whales, and fluctuating prey populations due to events such as El Niño may contribute to natural humpback mortality rates (Waring *et al*., 2006). Young or sick humpbacks seem to be particularly vulnerable to attacks by killer whales (*Orcinus orca*) and occasionally by larger predatory sharks (Waring *et al*., 2006). In the western North Atlantic, 14 percent (n=3365) of the appropriately photographed humpback whales bear scars, primarily on their flukes, from killer whale attacks (Katona *et al*., 1988; Waring *et al*., 2006). Although humpback whales and killer whales have been observed feeding near one another without aggressive interactions (Dolphin, 1987c), killer whales have been observed attacking and killing other species of baleen whales (Hancock, 1965; Baldridge, 1972; Silber *et al*., 1990).

Humpback whales are the top carnivores in a relatively simple food chain consisting of phytoplankton, zooplankton, small forage fish and crustaceans. Although the food chain is short, it does afford a mechanism for accumulation of natural and anthropogenic toxins from prey species to whale tissues through trophic transfer and biomagnification.

3.1.1.4 Status and Distribution

Humpback whales were an important commercial species throughout most of their range, including New England waters, until early in the twentieth century (Allen, 1916). Some taking of humpback whales occurred in northwest Atlantic waters until the mid-1950s. The International Convention for the Regulation of Whaling, Washington 1946, afforded the North Atlantic population of humpback whales full protection in 1955 (Best, 1993). Humpback whales were afforded endangered species status in the United States in 1970 (USFWS, 1986), and retain that status today. Although severely depleted by whaling, the species has shown good recovery over most of its range.

The most common anthropogenic source of mortality for humpback whales in the western North Atlantic is entanglement in commercial fishing gear (O'Hara *et al*., 1986; Lien *et al*., 1989a, b; Hofman, 1990; Volgenau and Kraus, 1990; Waring *et al*., 2006). Humpback whales in the Gulf of Maine stock become entangled most frequently in gill nets and trap/pot gear (such as lobster or crab), followed by weirs and seines (Waring *et al*., 2004). In inshore waters of Newfoundland, entanglement occurs most frequently in cod traps, followed by groundfish gill nets and salmon gill nets (Hofman, 1990, Waring *et al*., 2006). A total of 18 humpback whales were reported entangled in lobster gear in coastal waters between New Jersey and New England between 1976 and 1993 (NMFS, 1994). Two humpback whales were entangled in New Jersey, one in New York, and eleven in coastal waters of Massachusetts. Only one of the whales died as a probable result of the entanglement (NMFS, 1994). A review of mortalities and serious injuries for the years 2000 to 2004 reveal that four mortalities and eight serious injuries in the Gulf of Maine stock were attributable to fishery interactions (Waring *et al*., 2007). For the period of 2000 to 2004, three additional fishery-related mortalities and three serious injuries are on record for southeastern and mid-Atlantic waters; it is uncertain if any of these whales are from the Gulf of Maine stock (Waring *et al*., 2007).

Humpback whales are relatively tolerant of boats (Pett and McKay, 1990) and are seen frequently in the Great South Channel and Stellwagen Bank in the vicinity of commercial and recreational fishing vessels and whale watch boats. During the early 1970s, before whale watching became popular in Massachusetts Bay, humpback whales were difficult to approach in a small boat (Watkins, 1986). The whales usually diminished surface activities and moved away, emitting agonistic trumpeting sounds when approached too closely. However, during recent years humpback whales in nearshore waters often readily accept the presence of vessels, and some even "perform" various surface behaviors when approached by a whale watch vessel. Humpbacks in the western North Atlantic are more habituated to vessel approach than any other whale in the area (Watkins, 1986). As whales become more habituated to whale-watch and other vessel traffic, the chance of collision increases (Beach and Weinrich, 1989). There is some evidence of increased incidents of ship collisions in the Gulf of Maine (Waring *et al*., 2007). In NMFS records for 2000 to 2004, 10 records of injuries had some evidence of collision with vessels (Waring *et al*., 2007). Of these, 7 mortalities were as a result of the collision, and 2 did not have enough confirmation of collision as cause of death (Waring *et al*., 2007). Three of the 7 cases of mortality from vessel collision involved whales identified as members of the Gulf of Maine stock (Waring *et al*., 2007). In a recent study of stranded humpback whales along the Middle-Atlantic and southeast United States, 30 percent (n=20) had injuries potentially associated with a ship strike (Waring *et al*., 2006).

Figure BA-2 provides data on the sightings of humpback whales in the Gulf of Maine and Cape Cod regions. The sighting data indicates three areas of congregation, Georges Bank, Stellwagen Bank, and in the northern Gulf of Maine. One humpback whale has been reported in the vicinity of Monomoy Shoals, but none have been observed within Nantucket Sound. The sightings data should not be considered as an absolute documentation of the occurrence of any particular species, because the results are dependent in part on the level of effort that is expended in looking for whales. However, as a general indicator of where humpback whales are likely versus unlikely to occur, the data suggest that few or no humpback whales are likely to occur in the area of the proposed action during any phase of the proposed action.

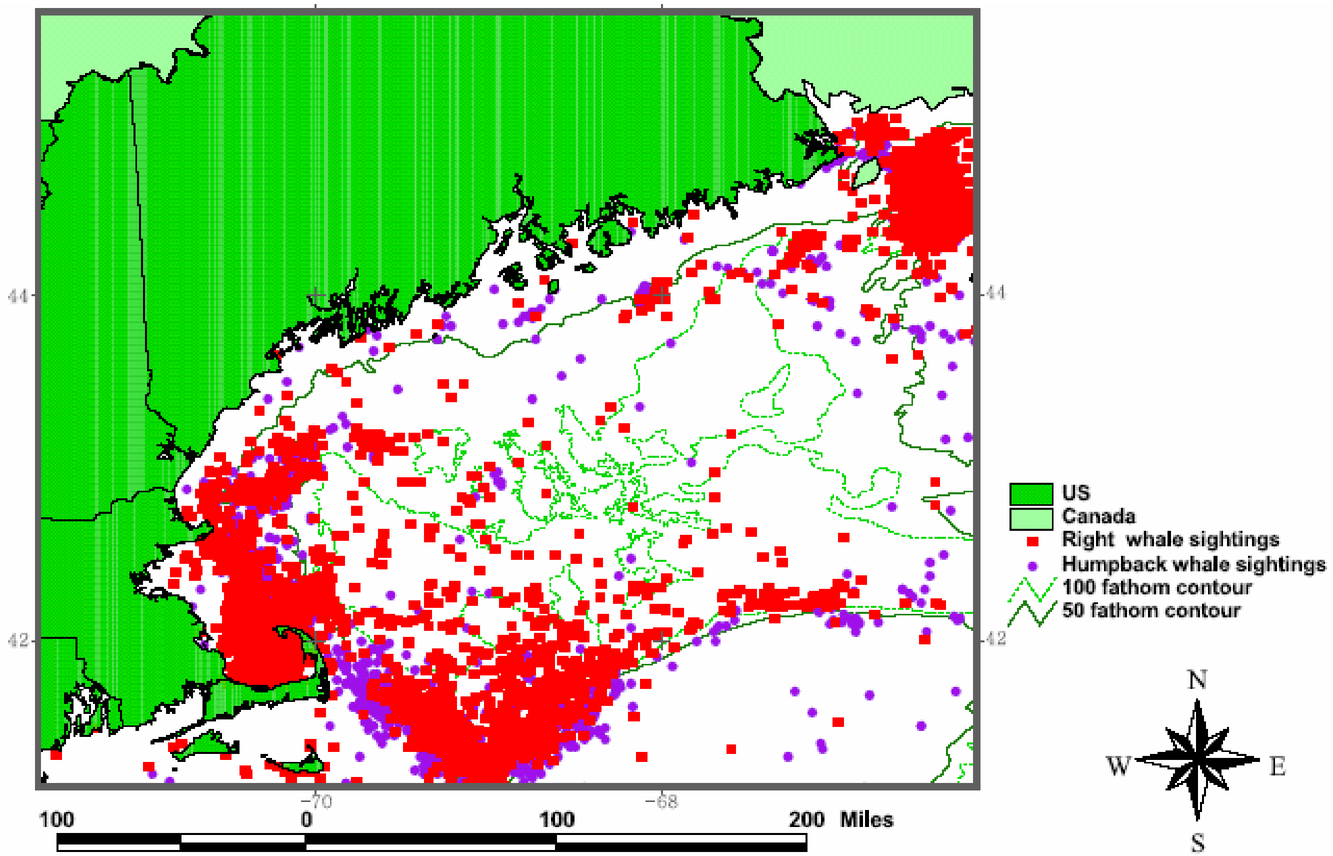


Figure BA-2.
North Atlantic Right and Humpback whale sightings through 2002 – Cape Cod North
(NMFS Northeast Fisheries Science Center, unpublished data)

3.1.2 Fin Whale

3.1.2.1 Species Description

Fin whales (*Balaenoptera physalus*) are present in all the major oceans of the world from the Arctic to the tropics, with greatest numbers in temperate and boreal latitudes (Evans, 1987). Although endangered, they are more common than other large whales in the temperate waters of the western North Atlantic, and are found along the continental shelf between Cape Hatteras and southeastern Canada in all seasons at depths of 69 to 328 ft (21 to 100 m) (Waring *et al*., 2006).

Because the fin whale is the most numerous of the large whales with the largest food requirements, it has the largest impact on the continental shelf ecosystem of any whale species, and may be a valuable indicator of the health of this area (Hain *et al.*, 1982).

Fin whales are long and slender, growing to a maximum size of 88 ft (27 m) and 161,000 lbs (73,000 kg), and individuals from the Southern Hemisphere tend to grow to a larger size than those in the Northern Hemisphere with females are generally larger than males (Slijper, 1978; Minasian *et al*., 1984). Color variations in fin whales range from dark gray to brown, asymmetrical coloring on their head, and white on the ventral sides of their belly, flukes and flippers. Distinctive features include the tall, falcate dorsal fin, the light pigmentation (or blaze) on the right side of the head, and the V-shaped gray-white "chevron" on the back and sides (Agler *et al.,* 1990).

3.1.2.2 Life History

Relatively little is known about reproduction in North Atlantic fin whales. Presumably, reproduction takes place during their winter sojourn off the mid- and south-Atlantic states. Some evidence suggests that calving occurs in coastal or offshore waters south of New Jersey between October and January, and wintering grounds are south of Cape Hatteras (Waring *et al.,* 2006). No mating or breeding is known to occur in the Gulf of Maine and Canadian waters (Waring *et al*., 2006).

Females reach sexual maturity after four to seven years, apparently depending on availability of food (Ohsumi, 1986). The size at sexual maturity is approximately 49.2 to 52.5 ft (15 to 16 m). Newborn fin whales are approximately 26.2 ft (8 m) long and are weaned at age seven months to one year (Waring *et al*., 2006). Fin whales may have a calf every two years (Agler *et al*., 1993). The average life span for fin whales ranges from 85 to 90 years (Evans, 1987).

Fin whales are euryphagous (have a broad diet), and feed on a wide variety of small schooling fish and crustaceans such as sand lance, capelin, euphausiids, copepods, squid (*Loligo* spp. and *Ilex* spp.) and myctophid fish (Katona *et al*., 1977; Overholtz and Nicolas, 1979; McKenzie and Nicolas, 1988; Piatt *et al*., 1989; Waring *et al*., 2006). Fin whales eat many of the same foods as humpback whales and the two species frequently are seen feeding together in spring and summer feeding areas (CeTAP 1982). Fin and humpback whales likely compete directly with cod, haddock, other piscivorous ground fish, and humans for food (Overholtz and Nicolas, 1979; Hain *et al*., 1985).

Feeding behaviors of fin whales are less well known than those of right and humpback whales. They appear to feed individually or in groups of two to 50 animals (CeTAP, 1982). Fin whales are streamlined, fast swimmers and typically cruise at speeds of five to ten km/hr (Hain, 1991b). They apparently use this speed to feed on less dense, more widely separated patches of prey species (Whitehead and Carlson, 1988). However, Brodie *et al*. (1978) observed high densities of euphausiids in fin whale stomach contents, suggesting that fin whales focus their feeding efforts on dense aggregations of prey when available.

3.1.2.3 Population Dynamics

The estimated modern worldwide population of fin whales is 105,000 to 125,000 individuals (Würsig, 1990). Fin whales are the more abundant and frequently sighted of the endangered great whales visiting the coastal waters of the northeastern United States. The 2006 NMFS Marine Mammal Stock Assessment Report estimates the western North Atlantic stock abundance at 2,814 (CV=0.21), with a minimum size estimate of 2,362, based on a 1999 line-transect sighting survey conducted by a ship and airplane covering waters from Georges Bank to the mouth of the Gulf of St. Lawrence (Waring *et al*., 2007). Because of the fin whale's extended distribution and poorly understood population structure, this is considered to be an extremely conservative estimate.

Stocks of fin whales in the United States, Nova Scotia, and Labrador are believed by some to be from one or a few closely related populations, whereas the Icelandic population is distinct (Waring *et al*., 2006). However, the population structure is not well understood. Waring *et al*. (2007) reported that a recent genetic study published by Berube *et al.* in 1998 supports the presence of several subpopulations first suggested by Kellogg in 1929. Because little is known about the winter breeding and calving areas of fin whales, it is uncertain whether fin whales segregate into a few separate breeding populations that form several distinct summer feeding aggregations occupying different feeding grounds. It has been suggested different subpopulations use the same feeding grounds (Waring *et al*., 2007). It is unclear whether fin whales in the North Atlantic split into separate feeding stocks. Mitchell (1974) suggested that fin whales seen off the United States, Nova Scotia, and Labrador coasts were from one or a few closely related populations. Fin whales often travel alone, but an average group size ranges from two to three individuals. Groups can get as large as 65 individuals, though groups of more than ten are unusual.

Because fin whales are the fastest swimmers of the baleen whales, it is unlikely that predation by killer whales and large sharks is an important cause of natural injury and death, except possibly among the very young or sick. Nevertheless, the literature contains some records of attacks by killer whales on fin whales (Tomlin, 1957). Other natural mortality factors may include accumulation of biological toxins from prey species to whale tissues through trophic transfer and biomagnification. At the time in 1987 when fourteen humpback whales died from consumption of mackerel contaminated with phytoplankton toxin, two partly decomposed fin whales washed up on the western shore of Cape Cod Bay at Marshfield and Manomet, MA (Waring *et al*., 2006). The cause of death was not determined, but may have been consumption of the contaminated fish, as fin and humpback whales eat similar foods.

3.1.2.4 Status and Distribution

Fin whales were listed as endangered throughout their range in 1970. Because of their high cruising speed, fin whales were not harvested commercially in large numbers until other species, such as slow-moving right whales, were depleted and whalers developed high-speed boats (Leatherwood *et al*., 1976). Nonetheless, more than 700,000 fin whales were harvested worldwide in the twentieth century (NMFS, 1994). A fishery for this species existed in Nova Scotia from 1964 to 1972 (Waring *et al*., 2006). During this period, 3,528 individuals were harvested. Commercial harvesting of fin whales elsewhere in the world continued at least into the early 1990s. However, stocks of fin whales have not been as severely depleted by commercial whaling as other stocks of large whales.

It is probable that the hazards that affect humpback whales also affect fin whales. Fin whales often are caught in fish traps deployed in offshore Canadian waters. Between 1969 and 1986, twelve fin whales were entangled in fishing gear, usually groundfish gill nets, in inshore waters of Newfoundland (Hofman, 1990). Five of these whales (42 percent) died. Between 1975 and 1990, three fin whales were observed entangled in fishing gear in the Gulf of Maine (Volgenau and Kraus, 1990). All entanglements were in lobster gear. The commercial lobster industry reported six instances of fin whale entanglements in lobster gear between November 1975 and January 1991 (NMFS, 1994). All but one of the whales was alive when sighted. Three of the entangled whales were sighted in Massachusetts, two in New York, and one in Maine. Such entanglements may indicate that fin whales sometimes feed near or at the bottom. NMFS fisheries observers reported no confirmed fisheries-related fin whale mortalities for the period 2000 to 2004 (Waring *et al*., 2007). Anecdotal records from NMFS for the same period found three records of fishery related mortality and one record resulting in serious injury to fin whales, yielding a minimum annual rate of mortality and serious injury from fishery interaction of 0.8 individuals for United States and Bermuda's waters (Waring *et al*., 2007). An additional five records for the same period did not contain enough information to determine if the entanglement was severe enough to cause serious injury or if the entanglement contributed to mortality. In 2004, the CCS documented three entangled fin whales from Stellwagen Bank, North Carolina, and the Bay of Fundy (CCS, 2004).

Figure BA-3 provides data on the sightings of fin whales in the Gulf of Maine and Cape Cod regions. The sighting data indicates three areas of congregation, Georges Bank, Stellwagen Bank, and in the northern Gulf of Maine. One fin whale has been reported in the area off the Falmouth coast, but none have been observed within the rest of Nantucket Sound or Horseshoe Shoal. The sightings data should not be considered as an absolute documentation of the occurrence of any particular species, because the results are dependent in part on the level of effort that is expended in looking for whales. However, as a general indicator of where fin whales are likely versus unlikely to occur, the data suggest that very few fin whales are likely to occur in the area of the proposed action during any phase of the proposed action.

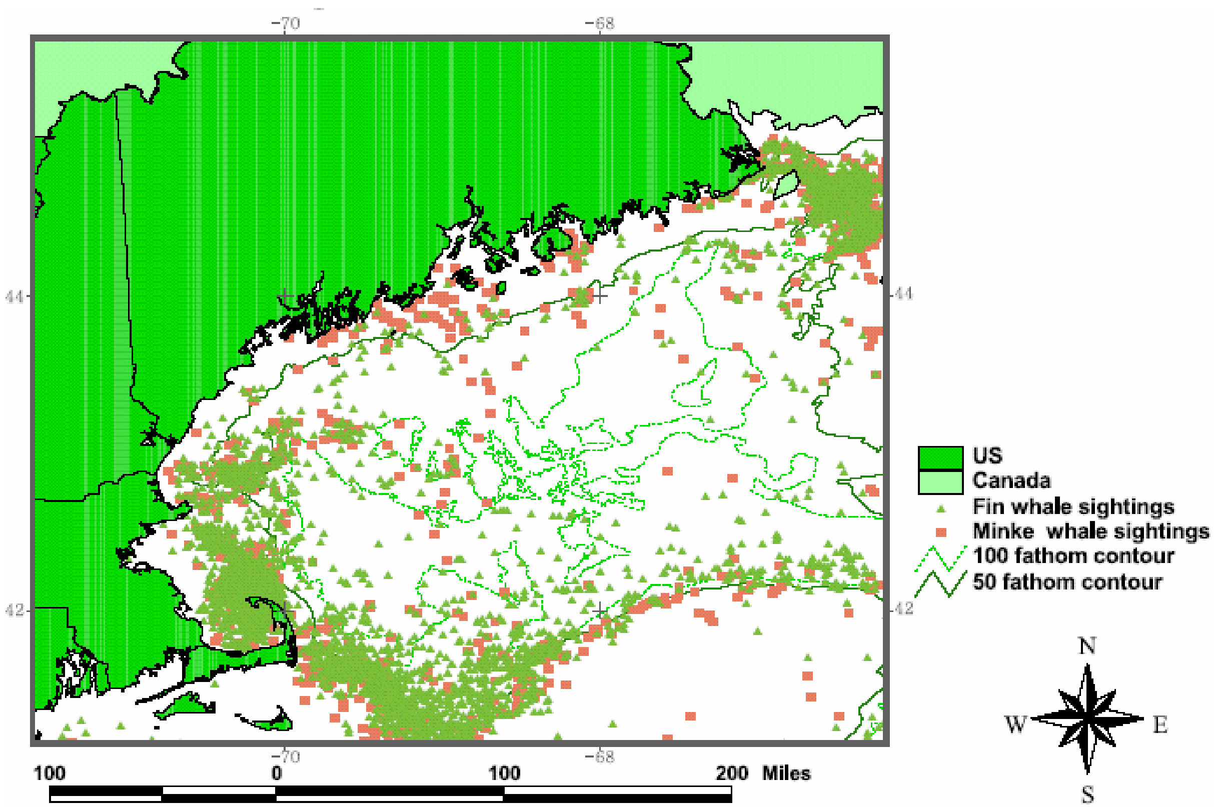


Figure BA-3.
North Atlantic Fin and Minke whale sitings through 2002 – Cape Cod North
(NMFS Northeast Fisheries Science Center, unpublished data)

3.1.3 North Atlantic Right Whale

3.1.3.1 Species Description

The North Atlantic right whale (*Eubalaena glacialis*) was a prime target of early whale fisheries from the 1100s through the early 1900s, due to its coastal distribution, slow swimming speed, high oil yield, and characteristic of floating when dead (Brown, 1986; Aguilar, 1986). Due to intense exploitation, it is one of the rarest of the large whales and is in danger of extinction. Historically, there was an eastern and western stock of right whales in the North Atlantic, but current evidence suggests that the eastern stock may be extinct or on the verge of extinction (Brown, 1986; Best, 1993).

The majority of right whales sighted in the North Atlantic Ocean are approximately 36.1 to 49.2 ft (11 to 15 m) in length and weigh up to 140,000 lbs (63,503 kg) (Kraus *et al.,* 1988). Females are larger than males. Right whales can be distinguished from other baleen whales by their black color, stocky body, the absence of a dorsal fin, short, paddle-shaped flippers, large head (more than 25 percent of the total body length), and a strongly bowed lower jaw. The distinct "V-shaped" blow provides a means of identification from a distance. Individuals are identified through the distribution and size of thickened, patches of epidermis called callosities on the rostrum, chin, and lower lips varies among right whales and can be used in conjunction with other unique features, such as scars and pigmentation patterns (Payne *et al.,* 1984; Kraus *et al.,* 1986).

3.1.3.2 Life History

In both the northern and southern hemisphere, females give birth to their first calf at an average age of nine years (NMFS, 2005). Calves are 18.0 to 19.7 ft (5.5 to 6 m) in length at birth (Best, 1994). Gestation lasts about a year, and the mean calving interval for female right whales is less than four years (NMFS, 2005; Waring *et al*., 2006). The coastal waters of Georgia and northeastern Florida are the only known calving grounds of the North Atlantic right whale, but limited surveys recently conducted along the Mid Atlantic suggest some mother-calf pairs use the area from Cape Fear North Carolina to South Carolina as a wintering/calving area as well (NMFS, 2005). The calving season extends from late November to early March, and appears to peak in January.

Generally, right whales are found along the east coast of North America (CeTAP, 1982) but, in the last century, have been seen as far north as Greenland, Iceland, and arctic Norway, as far east as Bermuda, and as far south as the Gulf of Mexico (Waring *et al*., 2006). Right whales, like other large whales, are migratory animals (Gaskin, 1982). Some female right whales have been observed to migrate more than 1800 miles (2900 km) from their northern feeding grounds to the southern calving/wintering grounds (Waring *et al*., 2006). Right whale seasonal movements occur among the following five areas of "high use" 1) Coastal Florida and Georgia (Sebastian Inlet, Florida to the Altamaha River, Georgia); 2) The Great South Channel (east of Cape Cod); 3) Massachusetts Bay and Cape Cod Bay; 4) The Bay of Fundy; and 5) The Scotian Shelf, including Browns and Baccaro Banks, Roseway Basin and areas to the east (NMFS, 2005).

The primary prey of right whales in the western North Atlantic is calanoid copepods, *Calanus finmarchicus*, and juvenile euphausiids (Nemoto, 1970; Watkins and Schevill, 1979; Kraus and Prescott, 1982; Murison and Gaskin, 1989), and secondarily the copepods *Pseudocalanus minutus* and *Centropages* sp. (Marx and Mayo, 1992). Both the density of plankton patches and the proportion of caloric-rich adult (Stage V) copepods appear to be factors influencing the foraging threshold of right whales (Murison and Gaskin, 1989; Marx and Mayo, 1992; Waring *et al*., 2006).

3.1.3.3 Population Dynamics

A census in 1992, based on photo-identification techniques, estimates the western North Atlantic population at 295 individuals (NMFS, 2005). An updated analysis using the same method gave an estimate of 299 animals in 1998 (Waring *et al.,* 2007). The 1998 IWC right whale workshop accepted an estimate of about 300 individuals for the western North Atlantic population based on this information (NMFS, 2005). Review of the photo-id recapture database in October 2005 noted that 306 individually recognized whales were known to be alive during 2001 (Waring *et al*., 2007). Because this was nearly a complete census, it is presumed that this represents a minimum population size estimate (Waring *et al*., 2007).

The use of a given nursery by females is culturally transmitted (Schaeff *et al.,* 1992). Not all mother-calf pairs that are seen in the southeastern United States region wintering grounds are observed the following summer in the Bay of Fundy (Waring *et al*., 2006). In addition, based on mitochondrial DNA (mtDNA) data, one of the three known matrilines does not appear to bring its calves to the Bay of Fundy summer nursery area (Schaeff *et al.,* 1992). Therefore, it is likely that at least one other nursery area exists. Further work has identified two additional matrilines (NMFS, 2005).

Sei whales (*Balaenoptera borealis*) (Mitchell, 1975; Mitchell *et al.,* 1986), sand lance (*Ammodytes spp*.) (Waring *et al*., 2006), and planktivorous species could represent a source of competition for the right whale's preferred prey *(Calanus finmarchicus).* In 1986, when *C. finmarchicus* levels were high in the Gulf of Maine, right whales, fin whales, and sei whales were the dominant whales in the area. Although Waring *et al*. (2006) reported an increase in sei whales in the Great South Channel and Nova Scotian Shelf, there is little quantitative evidence of direct competition between right whales and these other species. In addition, *C. finmarchicus* populations are highly variable, and little of this variation is due to predation pressure (McLaren *et al.,* 1989; Tande and Slagstad, 1992).

3.1.3.4 Status and Distribution

The pre-exploitation western North Atlantic population is estimated to have numbered 10,000 animals (Waring *et al*., 2006). Commercial harvest of the species over the centuries resulted in the decimation of the population to possibly less than 50 animals at the turn of the century (Waring *et al*., 2006). Although protected by international law since 1935, currently the population is believed to contain only about 300 individuals and it's unclear as to whether its abundance is remaining static, undergoing modest growth or, as recent modeling exercises suggest, in decline (NMFS, 2005). The North Atlantic right whale has been listed as endangered under the Endangered Species Act (ESA) since its passage in 1973 (35 FR8495, June 2, 1970). The NMFS approved a recovery plan in December 1991, under Section 4(f) of the Endangered Species Act (NMFS, 1994), and a revised plan incorporating revisions from July 2001 and August 2004, was approved on May 26, 2005.

The greatest known current cause of right whale mortality in the western North Atlantic is collision with ships (NMFS, 2005). Of 45 confirmed deaths of western North Atlantic right whales between 1970 and 1999, 16 (35.6 percent) are known to have been caused by ship strikes (Waring *et al*., 2007). Entanglement in fishing gear is the second largest human-related threat to right whales. Recent analyses of scarification of right whales showed that 75.6 percent of 447 whales examined during 1980 to 2002 were scarred by fishing gear (Waring *et al*., 2007). Habitat change and degradation is also a key environmental factor affecting the rate of recovery of the right whale (NMFS, 2005; Gaskin, 1982). Neonatal and juvenile right whales appear to be the most vulnerable and impacted part of the population. Analyses of sighting data between the northern feeding areas and the southern calving areas indicate that about 17 percent of calves die within their first year of life. After the first year, mortality rates drop to an average of 3 percent for the next three years, or a total of 27 percent mortality for the first four years of life (Kraus, 1990). Of the known 45 right whale mortalities that occurred from 1970 to 1999, 13 (28.9

percent) deaths were neonates believed to have died from perinatal or other natural causes (Waring *et al*., 2007). Thus, even a few incidental deaths may greatly affect the rate of recovery in a drastically reduced population with such a long reproductive cycle (Best, 1988). From 2000 to 2004 the average reported mortality and serious injury to right whales due to ship strikes was 1.2 whales per year (U.S. waters, 1.0; Canadian waters, 0.2) (Waring *et al*., 2007).

In May 2000, NMFS requested consultation on Fisheries Management Plans for multiple fisheries because of several right whale entanglements in 1999 and new information provided by the International Whaling Commission indicating that the North Atlantic right whale population may be declining. As described in NMFS (2005), the Biological Opinions identified reasonable and prudent alternatives to be implemented by NMFS which included: developing and implementing annual restrictions to fishing operations aimed at minimizing interactions between fisheries and right whales; implementing a "dynamic area management" program to supplement annual restrictions with temporary closures at times and in places where right whales aggregate; and expanding gillnet gear modification research program and extension of gear modification requirements to include waters off mid-Atlantic and southeast states. NMFS implemented these fishery restrictions through three rules that (1) make further modifications to commercial fishing gear (67 FR 1300, January 10, 2002; see also 67 FR 15493, April 2, 2002; 67 FR 59471, September 23, 2002), (2) establish restricted areas based on annual, predictable aggregations of right whales (67 FR 1142, January 9, 2002), and (3) establish a system for restricting fishing in areas where unexpected aggregations of right whales are observed (67 FR 1133, January 9, 2002; see also 68 FR 51195, August 26, 2003).

The revised recovery plan for the North Atlantic right whale (NMFS, 2005) identified that the most immediate need for the North Atlantic Right Whale is to reduce or eliminate human-related deaths and injuries. At present, these result primarily from ship collisions and fishing gear entanglement (NMFS, 2005). The new recovery plan also identified that the secondary, but still high priority, needs to involve other actions of importance to the species' management, including characterization and monitoring of important habitat, and protection of this habitat; and identification and monitoring of the status, trends, distribution and health of the species (NMFS, 2005).

Figure BA-2 provides data on the sightings of right whales in the Gulf of Maine and Cape Cod regions. The sighting data indicates three areas of congregation, Georges Bank, Stellwagen Bank, and in the northern Gulf of Maine. Right whales have been reported off Monomoy and the northern tip of Nantucket Island, but none have been observed within the rest of Nantucket Sound or Horseshoe Shoal. The sightings data should not be considered as an absolute documentation of the occurrence of any particular species, because the results are dependent in part on the level of effort that is expended in looking for whales. However, as a general indicator of where right whales are likely versus unlikely to occur, the data suggest that very few right whales are likely to occur in the area of the proposed action during any phase of the proposed action.

3.2 Sea Turtles

3.2.1 Kemp's Ridley Sea Turtle

3.2.1.1 Species Description

The Kemp's ridley (*Lepidochelys kempi*) sea turtle is distributed throughout coastal areas of the Gulf of Mexico and the northwestern Atlantic Ocean, and is assumed to constitute a single stock (TEWG, 1998). A small sea turtle, adult Kemp's ridley females have carapace lengths of 2 to 2.25 ft (0.6 to 0.7 m) and weigh 77 to 100 lbs (35 to 45 kg) (NRC, 1990). Most ridleys that visit the east coast of the United States are juveniles, averaging 0.8 to 1 ft (0.25 to 0.3 m) long and weighing about 6.6 lbs (3 kg) (NMFS, 1988; NOAA, 1991).

3.2.1.2 Life History

Female ridleys reach sexual maturity when they reach a carapace length of about 22 to 23 inches (0.58 to 0.60 m) and are six to nine years old (Márquez, 1994). The mature females nest annually and produce one to three (average about 1.7) clutches per season containing a total of about 120 to 190 eggs. Little is known about the sex ratio of ridley turtles or about the life history of the males. Nearly all reproduction takes place along a single 9 mile (15 km) stretch of beach near Rancho Nuevo, Mexico, about 200 miles (322 km) south of Brownsville, Texas. Nesting occurs in a highly synchronized manner with large numbers of females coming ashore within a period of a few daylight hours (NRC, 1990). Longevity is greater than 20 years.

Following a pelagic feeding stage shortly after hatching and lasting for several months (Carr, 1986a), juvenile ridleys move into shallow coastal waters to feed and grow. The young juveniles often forage in water less than one meter deep, but they tend to move into deeper water as they grow (Ogren, 1989). In New England waters, nearly all feeding takes place on or near the bottom in shallow water (Morreale and Standora, 1989, 1992). The deepest recorded dive of a juvenile ridley was to 69 ft (21 m); dives usually level off at about 50 ft (15 m) if the bottom isn't reached (Morreale and Standora, 1989).

All the ridley turtles in New England waters are two- to five-year old juveniles with carapace lengths of 8.6 to 15 inches (22 to 38 cm) (Burke *et al*., 1989; Morreale and Standora, 1989). They begin arriving in northern waters in late May and June each year and remain in shallow nearshore waters, particularly in the bays on eastern Long Island, during the summer (Keinath *et al*., 1987; Musick and Limpus, 1997). They begin leaving the area in mid-September and most have left for warmer southern waters by the beginning of November. Some ridleys may hibernate over the winter in nearshore sediments (Carminati *et al*., 1994). Most of the ridleys observed after the beginning of November are cold-stunned. Ridleys become sluggish and have labored breathing when the temperature falls below 55.4 ^{o}F (13 ºC); feeding ceases below 50 ^{o}F (10 ºC), and they die when water temperatures reach between 43.7 and 41 ^{o}F (6.5 to 5.0 ºC) (Schwartz, 1978).

In coastal waters of New York and New England, young ridleys consume several species of crabs, including in order of decreasing preference, spider crabs (*Libinia emarginata*), lady crabs

(*Ovalipes ocellatus)*, and rock crabs (*Cancer irroratus*) (Morreale and Standora, 1992, 1989). Crustaceans represent more than 80 percent of the diet of juvenile ridleys in the New York Bight (Burke *et al*., 1994). Other food items found in ridley stomachs include mollusks and algae. The preference for spider crabs over lady crabs, despite the fact that the latter is more abundant in ridley foraging habitat, is probably due to the greater ease of capture of the slower moving spider crabs by the small turtles (Morreale and Standora, 1989). Ridley turtles make long dives to the bottom and may feed on the bottom for an hour or more at a time; one turtle was observed burrowing in the bottom of Long Island Sound (NMFS, 1988). During daylight hours, ridleys spend most of their time under water. In a typical dive the turtle spends about 56 percent of its time in the upper third of the water column, 12 percent in the middle, and 32 percent of its time on the bottom (Morreale and Standora, 1989). In water deeper than about 50 ft (15 m), the turtles usually dive to a depth of 19.7 to 32.8 ft (6 to 10 m) where they appear to be swimming in a directed manner.

3.2.1.3 Population Dynamics

Estimates of adult abundance indicated 9,600 individuals in 1966, 1,050 in 1985, and 3,000 in 1995 (TEWG, 2000). The total population, adults and juveniles, may number 22,000 to 110,000 individuals. The total nesting population of females during the mid- to late-1980s has been estimated to number about 600 individuals, with each female laying about two clutches of eggs per year (Pritchard, 1990). When compared to the estimated number of nests in 1947 (92,000), this is the most severe population decline documented for any species of sea turtles (NRC, 1990).

Several stages in the life cycle of Kemp's ridley turtles are sensitive to natural and anthropogenic disturbance. Each year between November and January when ocean water temperatures are falling, small numbers of ridley turtles become stranded and die on beaches of the north and east shores of Long Island and Cape Cod Bay (see Figure BA-4), due to cold stunning (NOAA, 1991; Morreale and Standora, 1992). When the water temperature drops below about 53.6 ^{o}F (12 ºC), the metabolic rate of these cold-blooded reptiles decreases to the point where they are unable to swim and digest food; they become comatose and may die if not warmed quickly. A total of 115 ridley turtles were stranded on Cape Cod beaches between 1977 and 1987 (Danton and Prescott, 1988). For the period of 1990 to 2001, between nine and 216 ridleys strandings were reported in Massachusetts waters, and one ridley stranding was reported in Rhode Island waters (Sea Turtle Stranding and Salvage Network, unpublished data). Sea turtle stranding data collected by the Massachusetts Audubon Wellfleet Bay Wildlife Sanctuary (MA Audubon, 2005b) indicate that 79 and 32 kemp’s ridleys were reported stranded on Cape Cod beaches in 2003 and 2004, respectively. Cold stunned ridleys have stranded as far south as the Indian River Lagoon, FL (Wilcox, 1986). However, as shown in Figure BA-4, ridley sea turtles are much more likely to become stranded on the north shore of Cape Cod, and in the 1980-1997 timeframe, only one was found in the vicinity of Waquoit Bay. The strandings data are not the equivalent of sightings data, and may or may not represent density or abundance of occurrence, but may rather reflect a behavioral component of their seasonal movement patterns.

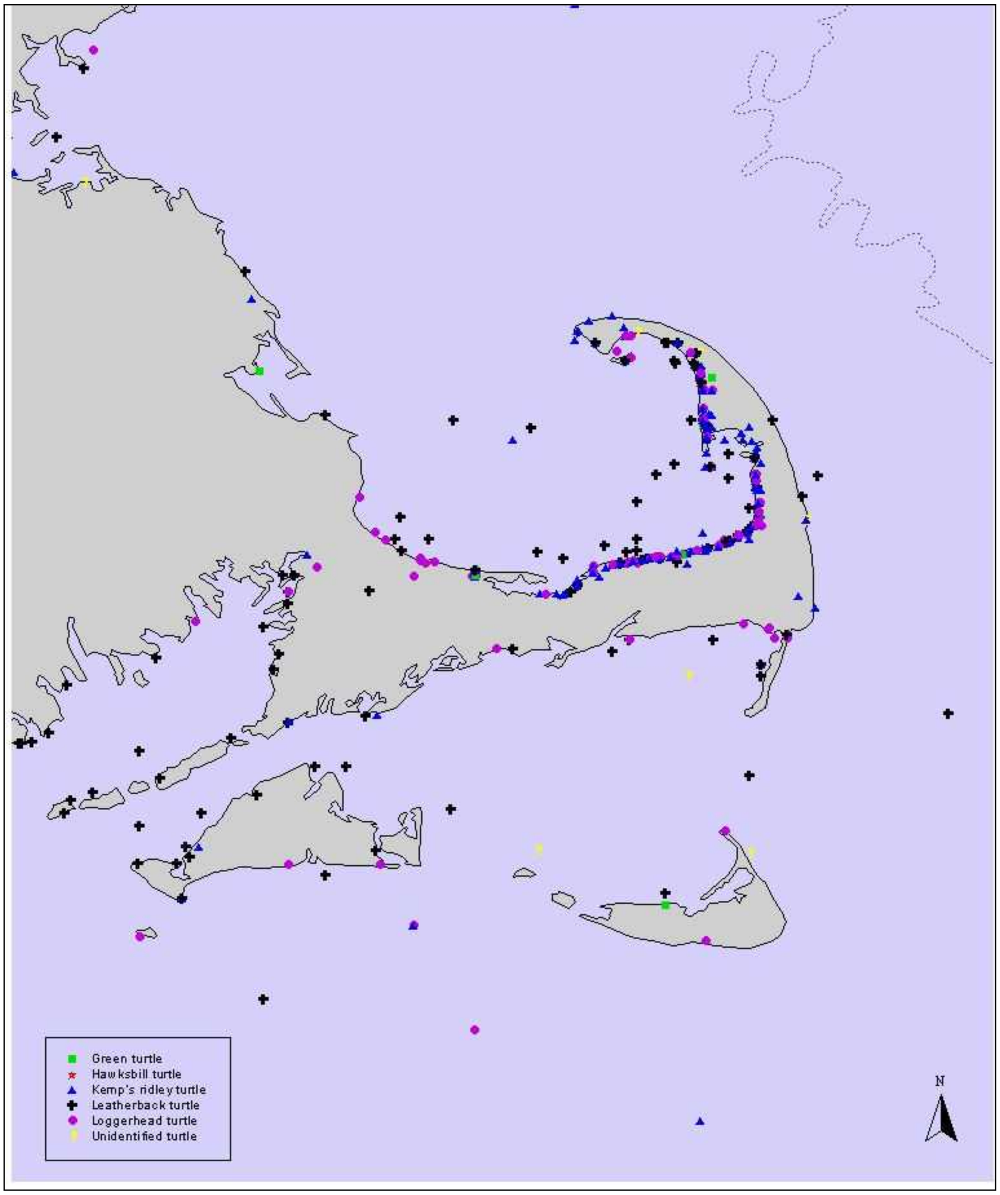


Figure BA-4.
Sea Turtle strandings on Cape Cod, Nantucket, and Martha's Vineyard Areas for the period 1980 to 1997
(NMFS unpublished data)

3.2.1.4 Status and Distribution

The Kemp's ridley sea turtle was listed under the Endangered Species Act as endangered on December 2, 1970, and status has remained unchanged as it is the most endangered sea turtle in the world.

A major cause of sea turtle mortality attributable to humans is entanglement in fishing gear, particularly shrimp nets before the implementation of turtle excluder devices (NRC, 1990). Most of the mortalities attributable to entanglement in shrimp nets are in the Gulf of Mexico, with an estimated mortality of about 11,000 individuals in the shrimp fisheries of the Gulf of Mexico and Atlantic coastal waters from Florida to North Carolina (Henwood and Stuntz, 1987). Other fishing-related deaths, caused by entanglement in lobster gear and pound nets, may result in an additional 50 to 500 deaths of Kemp's ridley turtles each year (O'Hara *et al*., 1986; Morreale and Standora, 1989). Ridley turtles, being benthic feeders, tend to become entangled in debris, including abandoned fish and crab traps, on the bottom. This incidental catch could represent as much as 7.5 percent of the hatchling ridleys produced each year, assuming that the 800 nests produced a total of 80,000 hatchling ridley turtles each year. This additional mortality undoubtedly is contributing to the rapid decline in the population of Kemp's ridley turtles.

Under some circumstances, chemical pollution may be a threat to ridley turtles. As part of the Sea Turtle Head Start Program, 12,422 one-year-old ridley turtles were tagged and released between 1979 and 1987 (Manzella *et al*., 1988). In 1982, 1,325 ridleys were released 3.7 to 6.2 miles (6 to 10 km) off the Texas coast in floating patches of *Sargassum* weed. More than 28 percent of the turtles washed ashore within 14 days of release, and most were coated with oil or had ingested tar balls, probably associated with the *Sargassum*. Because early pelagic stage ridleys are thought to congregate and feed in rafts of *Sargassum*, they may be vulnerable, as juvenile loggerhead turtles are (Carr, 1987), to floating oil and nondegradable debris that tends to collect in drift lines of *Sargassum*. Ridleys feeding in *Sargassum* rafts or on benthic prey may accumulate metal and organic contaminants from their prey.

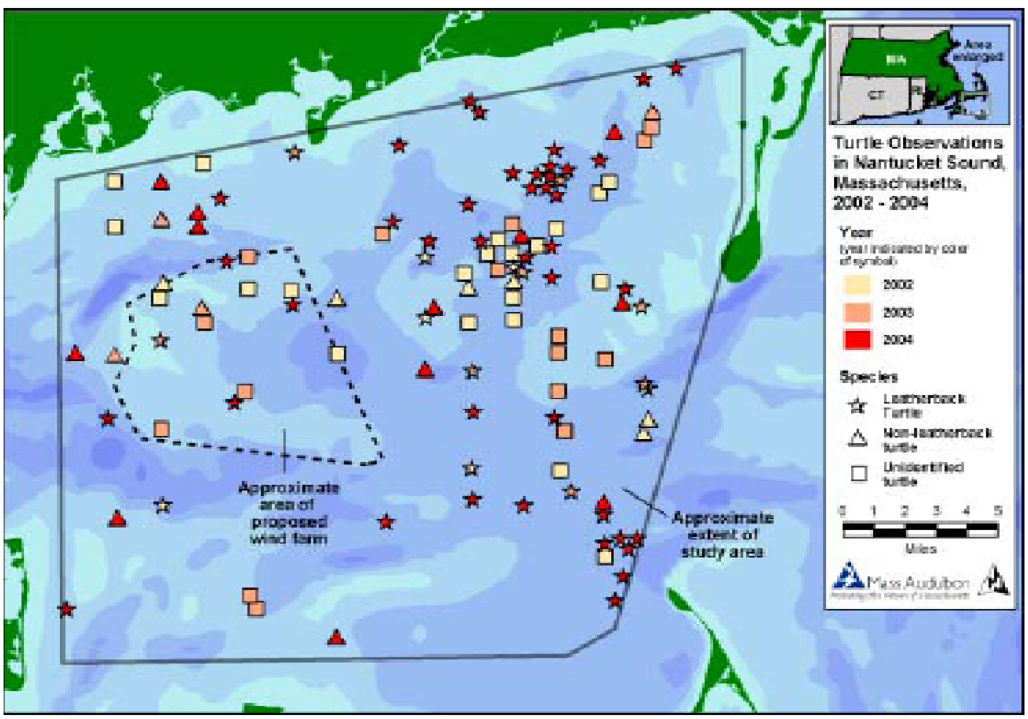


Figure BA-5.
Incidental observations of 115 sea turtles made during 35 pre-migratory staging period aerial surveys of Nantucket Sound, Massachusetts, 2002-2004
(MA Audubon 2005a)

In comparison to Figure BA-4, Figure BA-5 presents incidental observations of sea turtles made during late summer while performing surveys of birds from an airplane. Given the challenges of identifying sea turtle species from a moving airplane, the majority of the sightings are not species specific. During the 2002 to 2004 study period, sea turtles where observed within the area of the proposed action in Nantucket Sound. If Ridley sea turtles were among those observed, and they were feeding, they would most likely be found in the shallower portions of Horseshoe Shoal at the western end where some scattered sea grass and macroalgae were observed by the Applicant. However, the greatest number of observations is located to the east of the area of the proposed action in deeper water.

3.2.2 Leatherback Sea Turtle

3.2.2.1 Species Description

Leatherback turtles (*Dermochelys coriacea*) forage in temperate and subpolar waters and nest on tropical beaches. The leatherback is the second most common turtle along the eastern seaboard of the United States, and the most common north of the 42°. N latitude. Leatherback turtles are the largest and most distinctive of the living sea turtles. Because of their unique anatomy and physiology, they are classified in a separate family, the Dermochelyidae, containing a single species (NMFS & USFWS, 1992). Leatherbacks reach a length of 5 to 5.5 ft (1.5 to 1.7 m) SLCL and a weight of 110 lbs (500 kg) (exceptionally 1985 lbs [900 kg]). Large outstretched front flippers may span 8.9 ft (2.7 m) in an adult. Lacking a keratinized shell, they are covered instead with a tough hide. Leatherbacks have a layer of subcutaneous fat that is 2.3 to 2.7 inch (6 to 7 cm) thick and circulatory adaptations to reduce the rate of heat loss through the flippers (Greer *et al.,* 1973). They respond to drops in ambient temperature by increasing metabolic heat production and so can maintain an internal body temperature well above ambient (Standora *et al.,* 1984; Paladino *et al.,* 1990). A leatherback in 45.5 °F (7.5 °C) seawater was able to maintain its core body temperature at 77.9 °F (25.5 °C) (Friar *et al.,* 1972). This endothermy allows leatherbacks to survive and feed in colder temperate waters than other sea turtles can tolerate. Therefore, adult leatherbacks are more widely distributed than other sea turtles in temperate and boreal waters throughout the world. However, all leatherbacks return to subtropical and tropical shores to nest.

3.2.2.2 Life History

Each female may nest up to ten times (mean frequency five to seven times, depending on year) in a single season at intervals of about ten days (Tucker, 1989). Females usually nest only every other year (NRC, 1990; Boulon *et al.,* 1994). Most nesting takes place during March and April (NOAA, 1991). A typical nest on a Culebra beach contains about 30 to 115 eggs (mean 70), each about 2.1 inches (5.4 cm) in diameter (Hall, 1990). Some of the eggs do not have a yolk and are infertile. The eggs hatch after about 65 days.

The seasonal distribution of leatherback sea turtles in the North Atlantic waters range from Cape Sable, Nova Scotia south to Puerto Rico and the U.S. Virgin Islands. Although endangered, leatherback turtles occur during the summer in North Atlantic waters from Florida to the Gulf of Maine, the Canadian Maritime Provinces, and occasionally as far north as Baffin

Island, Canada (Goff and Lien, 1988). New England and Long Island Sound waters support the largest populations on the Atlantic coast during the summer and early fall (Lazell, 1980; Prescott, 1988; Shoop and Kenney, 1992). Leatherbacks are observed frequently in lower Chesapeake Bay and off the mouth of the Bay during the summer, where they probably are feeding on locally abundant jellyfish (Barnard *et al.*, 1989).

Leatherback turtles are pelagic feeders, though they can dive to considerable depths. They feed throughout the water column to depths of at least 3280 ft (1000 m) (Eckert *et al.,* 1989) on jellyfish and other gelatinous zooplankton, such as salps, ctenophores, and siphonophores (Limpus, 1984). Most feeding dives average about 197 ft (60 m), but frequently extend to 985 to 1312 ft (300 to 400 m) (Eckert *et al.,* 1986, 1989) where they feed on deep-water gelatinous zooplankton, such as siphonophores and salps. Their seasonal inshore movements in New England waters have been linked to inshore movements of their preferred prey, the jellyfish (*Cyanea capillata)* (Lazell, 1980; Payne and Selzer, 1986). Leatherbacks have a notched upper jaw, an adaptation for grasping soft prey (Pritchard, 1971). They also possess a long digestive tract, about nine times longer than the length of the carapace, and a large caecum for holding the quantities of watery, gelatinous prey they need to consume to fulfill their caloric needs (Bjorndal, 1985).

3.2.2.3 Population Dynamics

Because they are a largely oceanic, pelagic species, estimates of their population status and trends have been difficult to obtain. In addition, only a small fraction of the North Atlantic population nests on beaches of the continental United States, mostly in Florida (NRC, 1990; Meylan *et al.,* 1994) and the U.S. Virgin Islands (Boulon *et al.,* 1994). Leatherbacks that visit U.S. Atlantic waters nest primarily along the coasts of Surinam and French Guiana, and to a lesser extent on the island of St. Croix and at Culebra, Puerto Rico (NRC, 1990; NMFS & USFWS, 1992; Boulon *et al.,* 1994). Nesting is scattered along isolated beaches throughout the Caribbean. Nesting females do not have the nest-site fidelity exhibited by Kemp's ridley turtles and tend to move to different beaches in different years (Tucker, 1990). Therefore, it has been difficult to estimate temporal trends in population size.

Between 100 and 900 leatherbacks visit coastal and continental shelf waters of the western North Atlantic ocean between Canada and North Carolina each year, with peak abundance in summer (Shoop and Kenney, 1992). As many as 115,000 adult female leatherbacks remain worldwide (Pritchard, 1982), though a more recent estimate places the adult female population at 34,500 (Spotila *et al.,* 1996). Spotila *et al.* (1996) estimate that between 7,813 and 13,833 female leatherbacks visit the largest Atlantic nesting colonies in French Guiana, Suriname, other locations in the Caribbean, and Gabon, West Africa each year.

3.2.2.4 Status and Distribution

The leatherback sea turtle was listed as endangered throughout its range on June 2, 1970, and status has remained unchanged (USFWS, 1986). Current estimates are that 20 to 30,000 females exist worldwide. Of all Atlantic sea turtles, leatherbacks are the most vulnerable to entanglement in fishing gear. Between 1992 and 1999, 6,363 leatherback turtles were caught by U.S. Atlantic tuna and swordfish longlines; 88 of those turtles died (NMFS-SEFSC 2001). Many of the same natural and anthropogenic factors that affect survival of loggerhead and Kemps ridley turtles also affect leatherbacks. Being a temperate water species, leatherbacks do not seem to be sensitive to cold temperatures, and strandings cannot be attributed to cold stunning.

Between 1986 and 1999, 42 to 170 leatherback turtles were reported stranded on the U.S. Atlantic coast each year. Most strandings were in Florida and New York. In Massachusetts and Rhode Island waters leatherback strandings were reported to range from four to 39 each year during the twelve year period of 1990 to 2001 (Sea Turtle Stranding and Salvage Network, unpublished data). For the period of 1980 to 1997, twelve leatherback strandings were recorded in Nantucket Sound (NMFS, unpublished data) (see Figure BA-4), primarily scattered along the southern shore of Cape Cod and along the northern shore of Martha's Vineyard. The causes of these strandings are not known. Leatherbacks are also very susceptible to entanglement in other fishing gear and in plastic debris (Mager, 1985; Witzell and Teas, 1994). Because of their preferred diet of gelatinous zooplankton, particularly jellyfish, leatherback turtles often ingest floating plastic debris, mistaking it for food (Wallace, 1985; O'Hara, 1989). Plastic bags blocked the stomach openings of 11 of 15 leatherbacks that washed ashore on Long Island during a two-week period (Balazs, 1985). Leatherbacks have also been entangled in lobster gear (O'Hara *et al.*, 1986; Sadove and Morreale, 1990) and long-lines (Balazs, 1985) in New York Bight and New England waters. Subsistence harvesting also places pressure on leatherback populations. Although leatherbacks are not harvested commercially for meat or other products, extensive subsistence harvesting of the females that come ashore to nest occurs throughout much of the tropical nesting range, including Guyana, Trinidad, and Columbia (NRC, 1990). Egg collecting is also intense in some areas.

Figure BA-5 presents incidental observations of sea turtles made during late summer while performing surveys of birds from an airplane. Given the challenges of identifying sea turtle species from a moving airplane, the majority of the sightings are not species specific. However, the leatherback turtle is the one species that occurs in the area of the proposed action that was able to be identified to species, for at least some of the observations. During the 2002 to 2004 study period, leatherbacks where observed within the area of the proposed action in Nantucket Sound, although they were most frequently observed east of the proposed action location where water depths tend to be 40 to 50 ft.

3.2.3 Loggerhead Sea Turtle

3.2.3.1 Species Description

The loggerhead sea turtle (*Caretta caretta*) is the more common and seasonally abundant turtle in inshore coastal waters of the western North Atlantic. Loggerhead turtles in Nantucket Sound are expected to be found in similar shallow coastal areas as those in the New York Bight area. In the New York Bight area, most sightings of loggerheads are in shallow coastal bays and estuaries where the turtles feed on benthic invertebrates, particularly crabs (Morreale and Standora, 1989). They rarely are observed in water depths of 65 ft (20 m) or more, and rarely feed at depths greater than about 50 ft (15 m).

Juvenile loggerhead turtles grow rapidly during their summer visits to northern coastal waters (Morreale and Standora, 1989). The increase in straight-line carapace (SLCL) of juvenile turtles in New York ranges from 4.1 inch/year (10.6 cm/year) for 15.7 to 19.7 inch (40 to 50 cm) individuals to 1.2 inch/year (3.0 cm/year) for 19.7 to 23.6 inch (50 to 60 cm) individuals. Growth rate slows as the turtles approach sexual maturity, which may occur after 12 to 45 years in the wild (Zug *et al*., 1983; Frazer and Ehrhart, 1985; Foster, 1994) when the turtles are about 29 to 35.5 inches (74 to 90 cm) SLCL (Dodd, 1988; Foster, 1994). Adult loggerheads from the Florida population may grow to more than 47 inches (120 cm) SLCL and weight more than 400 lbs (180 kg) (Ehrhart and Yoder, 1978).

3.2.3.2 Life History

Hatchling loggerheads crawl from their nests to the sea and then float at the surface entrained in surface currents that may transport them far out to sea and across ocean basins. They may lead a pelagic life for up to 6.5 to 12 years, with an average of eight years, drifting and feeding in the *Sargassum* community (Carr, 1986a, b, 1987; Bjorndal *et al.,* 1994; Bolten *et al.,* 1994; Bjorndal *et al.,* 2000). During this long pelagic period, the young turtles, termed "pelagic immatures" may make several transits of the North Atlantic Ocean in the Great Gyre of the Gulf Stream and grow from a newly-hatched size of 1.8 inch (4.5 cm) to about 15.7 to 23.6 inch (40 to 60 cm) straight carapace length (SCL) before moving inshore to coastal waters (Carr, 1987; Dodd, 1988) to benthic habitats. Loggerheads settle at an average size of 19.3 inch (49 cm) SCL, and are then known as "small benthic immatures" (Bjorndal *et al.,* 2000) and will occur from Cape Cod through southern Texas. "Large benthic immatures" sized at 27.6 to 35.5 inch (70 to 90 cm) SCL will continue to mature for up to another ten years before reaching reproductive maturity (Carr, 1987). 35.5 in (90 cm) SCL is considered the average size-to-maturity (NMFS-SEFSC, 2001).

Migratory behavior seems to be cued to sea surface temperatures, with preferred water temperatures off Cape Hatteras falling in the range of 57.2 to 82.4 °F (14 ºC to 28 ºC) (Shoop and Kenney, 1992; Coles *et al*., 1994). The Atlantic range of loggerhead turtles extends from Newfoundland to Argentina. Loggerheads occur in the Northeast from May 1 through November 15 (NOAA, 2005a). Typically loggerhead turtles are more abundant during spring and summer months in coastal waters off New York and the Mid-Atlantic States, and a small number of individuals may reach as far north as New England. In Northeast waters, these individuals consist mainly of juveniles (NOAA, 2005a). In the fall, loggerheads migrate southward to coastal waters off the south Atlantic states, particularly Florida, and the Gulf of Mexico. During the winter, the turtles tend to aggregate in warmer waters along the western boundary of the Gulf Stream off Florida (Thompson, 1988). In the spring, they congregate off southern Florida before migrating north to their summer feeding ranges (CeTAP, 1982). Loggerheads are found in water depths of 72.2 to 160.8 ft (22 to 49 m); they range from the beach to the continental shelf (Shoop and Kenney, 1992).

Both benthic immature and adult loggerheads may travel great distances to foraging grounds (TEWG, 1998). Adult loggerheads are primarily bottom feeders, foraging in coastal waters for benthic mollusks and crustaceans (Bjorndal, 1985). During feeding, they spend more than 57 minutes of each hour submerged (Thompson, 1988). Stomach contents from sub-adult loggerheads collected in Chesapeake Bay contained horseshoe crabs, cancer crabs, and blue crabs, with traces of *Sargassum* weed (Lutcavage, 1981). In New England coastal waters, they feed primarily on small benthic crabs, such as spider crabs, rock crabs, and green crabs (Burke *et al*., 1989; Morreale and Standora, 1989; Morreale and Standora, 1992). Loggerhead turtles stranded on Cumberland Island, Georgia, had been feeding on a variety of crabs, whelks, and mantis shrimp (Ruckdeschel and Shoop, 1988). Some turtles had large numbers of barnacles in their stomachs. Although loggerheads appear to feed primarily on the bottom on benthic invertebrates, they also take food from the water column or the water surface. Turtles frequently contain large amounts of sediment in their guts, probably ingested during feeding on benthic prey (Ruckdeschel and Shoop, 1988).

3.2.3.3 Population Dynamics

Loggerhead turtle population estimates are best obtained from nesting data. One modeling method incorporated nesting and stranding data to estimate the loggerhead population size for the period of 1989 to 1995; a second method incorporated aerial survey data in addition to nesting and stranding data, for the same period of time. The two mean post-pelagic (i.e., benthic immature and adult) loggerhead population estimates were 224,321 and 234,355, respectively (TEWG, 1998). Due to sampling biases, these numbers are believed to be underestimates (TEWG, 1998).

The TEWG (2000) reports that the South Florida subpopulation appears to be increasing and that no trends are apparent in the northern subpopulation. Confounding data for loggerheads in the Panhandle area, and sparse and/or incomplete data for the Yucatan and Dry Tortugas subpopulations cannot support trends analyses at this time (TEWG, 2000; NMFS-SEFSC, 2001). Fishery-independent trawl survey data from the Southeast Area Monitoring and Assessment Program (SEAMAP) covering the nearshore area from Cape Canaveral, FL to Cape Hatteras, NC for the period 1990 to 2000 have recently been analyzed (SCMRD, 2000). While catches have increased over time, the error around each year's point estimate is large and no statistically significant trend of increase in the in-water loggerhead population in the Western North Atlantic is apparent (SCMRD, 2000; NMFS-SEFSC, 2001).

At least five genetically distinct nesting assemblages exist in the western North Atlantic: the Florida Panhandle subpopulation, the South Florida subpopulation, the northern subpopulation (Amelia Island, Volusia County, FL and northward), the Yucatan Peninsula subpopulation, and the Dry Tortugas subpopulation (TEWG, 1998, 2000; NMFS-SEFSC, 2001). Most recent evidence suggests that the number of nesting females in South Carolina and Georgia may be declining, while the number of nesting females in Florida appears to be stable (The Oceanic Resource Foundation, 2005). As distinct reproductive populations, these nesting assemblages will not be replenished by regional dispersal if depleted.

The major sources of mortality of sea turtles, including loggerheads, caused by human activities include incidental take in bottom trawls, particularly shrimp trawls (Henwood and Stuntz, 1987; Thompson, 1988; NRC, 1990; Anonymous, 1992), coastal gill net fisheries, marine debris, and channel dredging (Thompson, 1988; NMFS, 1992). Loss of nesting habitat along the south Atlantic coast caused by coastal development has also likely slowed recruitment of sea turtles.

3.2.3.4 Status and Distribution

The loggerhead sea turtle (*Caretta caretta*) was listed as threatened throughout its range on July 27, 1978, under the Endangered Species Act and its status has not changed.

Strandings have caused a high number of mortalities for loggerhead sea turtles; however, natural causes of these strandings are not well understood. Between four and seventeen loggerheads stranded each year in Massachusetts and Rhode Island waters during the period from 1990 to 2001, though atypically high numbers of 72 and 56 loggerhead strandings were reported in Massachusetts in 1995 and 1999, respectively (Sea Turtle Stranding and Salvage Network, unpublished data). For the period of 1980 to 1997, seven loggerheads strandings were recorded on the shorelines in Nantucket Sound, primarily along the south coast of Cape Cod to the east of the area of the proposed action, and four strandings were reported on the southern shorelines of Martha's Vineyard and Nantucket (NMFS, unpublished data) (see Figure BA-4). Strandings occur most frequently in the fall and winter; these strandings may be caused by cold stunning (Morreale *et al*., 1992; Matassa *et al*., 1994). As with most marine turtles, prolonged exposure of loggerheads to low water temperatures, below about 46.4 ^{o}F (8 ºC), may result in dormancy, shock, and death. During the winters of 1985, 1986, and 1987, 28 loggerhead turtles became cold-stunned and washed ashore in the Bay system of eastern Long Island and along the north shore of the island (Morreale *et al*., 1992). The turtles became cold-stunned between early November and late January each year. However, cold stunning is not restricted to northern waters, as demonstrated by several documented cold stunning incidents involving loggerheads in the northern part of the Indian River Lagoon system in east central Florida (Witherington and Ehrhart, 1989; Schroeder *et al*., 1990).

Figure BA-5 presents incidental observations of sea turtles made during late summer while performing surveys of birds from an airplane. Given the challenges of identifying sea turtle species from a moving airplane, the majority of the sightings are not species specific. During the 2002 to 2004 study period, sea turtles where observed within the area of the proposed action in Nantucket Sound, some of which could have been loggerhead turtles. However, within the bird aerial survey study area, the greatest number of observations occurred in the deeper water areas east of the area of the proposed action.

3.2.4 Green Sea Turtle

3.2.4.1 Species Description

The green sea turtle (*Chelonia mydas*) is largely distributed in tropical and subtropical waters worldwide. Major green turtle nesting colonies occur in the central Atlantic on the beaches of Ascension Island (British Territory, South Atlantic Ocean), Aves Island (Venezuela), Costa Rica, and Surinam. The species has been observed along the United States' Pacific coastline from southern Alaska to Baja California, in U.S. Hawaiian waters, in the waters of most tropical islands in the central Pacific Ocean, and circumglobal in tropical and subtropical waters (NOAA, 2002; USFWS, 2002). In the Atlantic Ocean the green turtle occurs in Puerto Rico and the U.S. Virgin Islands and along the coast from Texas to as far north as Massachusetts waters with some degree of regularity; however, is considered an 'oceanic straggler in southern New England' by the USFWS (USFWS, 2006). In comparison to other sea turtle species, there have been minimal recordings of the green turtle as far north as Cape Cod. The green turtles found near Cape Cod are three to four year old subadults, which are approximately 24 to 30 inch (61.0 to 76.2 cm) long and weigh about 50 lbs (22.7 kilograms) (Prescott, 2000). Green turtle population trends are particularly difficult to assess because of annual fluctuations in numbers of nesting females, difficulties of conducting research on early life stages, and long generation time (NOAA, 2002).

Newly-hatched green turtles are approximately 5 millimeters (mm) (0.2 inches) straight carapace length (SCL) and weigh approximately 25 grams (g) (0.9 ounces). The adult stage of the species are the largest of the marine turtles, during which the green turtle ranges in size from approximately 2.3 feet (0.71 m) to 5 ft (1.5 m) SCL, and can weigh up to 440 lbs (200 kg) (Crite, 2000).

3.2.4.2 Life History

Green turtle hatchlings make their way from the nest to the sea, where they migrate along the coast from the rookeries to feeding grounds. They float at the surface and are carried by tropical and subtropical currents that may transport them far out to sea and across ocean basins, up to several thousand kilometers away (EuroTurtle, 2005). Little is known regarding the duration of the juveniles' pelagic life until they reach a late-juvenile/subadult phase. It is believed that the green turtle may spend up to ten years in the juvenile, pelagic life stage before shifting to a benthic feeding stage (Crite, 2000; Luschi *et al*., 2003). Numerous sources document that green turtles reach sexual maturity at various ages between 10 to 50 years of age (Crite, 2000; NOAA, 2002; EuroTurtle, 2005).

While nesting on the beach and beginning their oceanic/pelagic phase hatchlings forage on available planktonic organisms (Crite, 2000). As they increase in size, juvenile pelagic green turtles tend to feed on marine plants and organisms such as jellyfish, crabs, sponges, snails, and worms (Crite, 2000). After a number of years in the oceanic zone, these late juvenile/subadult turtles recruit to neritic developmental areas that are rich in sea grass and marine algae where they forage and grow until maturity. Upon attaining sexual maturity, once every few years, green turtles commence breeding migrations between foraging grounds and nesting areas (Seminoff, 2004). In years when they mate, green turtles migrate from several hundred to over a thousand miles across the ocean to the beaches where they hatched (Crite, 2000). Adult green turtles are primarily herbivorous, feeding on shallow-growing algae and sea grasses in the protected waters of reefs, bays, inlets, lagoons, and shoal areas (USFWS, 2002; Crite, 2000). During non-breeding periods adults reside at coastal neritic feeding areas that sometimes coincide with juvenile developmental habitats (Seminoff, 2004).

3.2.4.3 Population Dynamics

While there are no known records of documented green turtle feeding or nesting grounds along the beaches of New England, or more specifically, Nantucket Sound, documented accounts of green turtles in New England are most commonly instances of reported strandings.

In 2004, the World Conservation Union's (IUCN) Marine Turtle Specialist Group (MTSG) conducted a global assessment of the green turtle's worldwide population status. The MTSG's assessment focused on the number of mature individuals. Therefore, to accurately assess the population this assessment measured changes in the annual number of nesting females from 32 representative sites around the world. The index sites included all of the known major nesting areas and many of the lesser nesting areas for which quantitative data are available (IUCN, 2004). Turtle population estimates are best obtained from nesting data. Scientists can use annual estimates of the number of nests laid each year to determine indirectly the number of adult females nesting in a given year and the number of adult females in the population (TEWG, 1998). The main limitation to using nesting data to estimate population size is that the most mature life history stage of one gender is used to make estimates about the entire population. However, nesting data are becoming available over large geographic areas and longer time periods, lending to their utility in population modeling.

Eighteen, or 56 percent, of the 32 sites the MTSG assessed displayed overall declining trends in green turtle nesting activity. Subpopulation declines of over 50 percent have been identified in the eastern and western Atlantic Ocean; and declines of greater than 80 percent have been shown in the eastern, southern, and western Pacific Ocean, Southeast Asia, Indian Ocean, and Mediterranean Sea. The most common intentional impact that has been documented among declining subpopulations is egg harvest, which occurs at beaches along the Pacific Coast of Mexico and along islands of Indonesia, the Philippines, and Malaysia (IUCN, 2004).

The remaining 14, or 44 percent, of the 32 sites the MTSG assessed displayed stable or overall increasing trends in green turtle nesting activity. Stable populations were reported at the Galapagos Islands (Ecuador), Karan Island (Saudi Arabia), and Ras al Hadd (Oman). Increasing populations were reported at the following 11 sites: Ascension Island, Bijagos Islands (Guinea-Bissau, Africa), Comoros Islands (Indian Ocean), Florida, Hawaii, Heron Island (Australia), Raine Island, Sabah Turtle Islands (Malaysia), Surinam, Tortuguero (Costa Rica), and Yucatan (Mexico) (IUCN, 2004).

Specifically in the Atlantic waters of the United States, green turtles nest in small numbers in the U.S. Virgin Islands and Puerto Rico, and they nest in larger numbers along the east coast of Florida. Although the Florida nesting subpopulation appears to be increasing, annual nesting effort fluctuates by a factor of ten. In more abundant years, annual nest counts have reached the low thousands (SCDNR, Undated).

3.2.4.4 Status and Distribution

The green sea turtle was protected by the Endangered Species Act on July 27, 1978. The species is currently listed as threatened, except for populations of breeding colonies in the waters of Florida and along the Pacific coast of Mexico, where it is endangered. Threatened populations exist in all other areas where the species is known to occur.

The Sea Turtle Stranding and Salvage Network (STSSN) was formally established in 1980 to collect information regarding, and document strandings of marine turtles along the United States' Gulf of Mexico and Atlantic coastlines. The STSSN encompasses the coastal areas of an eighteen-state region from Maine through Texas, including portions of the U.S. Caribbean (NOAA, 2005a). The STSSN reported that a total of nine green turtles were stranded in Massachusetts and Rhode Island waters between 1998 and 2001 (STSSN, 2005) provides regional data, which is not available on a state-specific basis, and reports a total of 14 green turtles were stranded in New York, Massachusetts, Connecticut, and Rhode Island waters between 2002 and 2005 (STSSN, 2005).

The Wellfleet Bay Wildlife Sanctuary, which is part of the Massachusetts Audubon Society (Mass Audubon), coordinates the Cape Cod Sea Turtle Stranding Network (CCSTSN). For the period of 2003 to 2004, CCSTSN reported five green turtle strandings on Cape Cod beaches, and one green turtle stranding on the shoreline of Chappaquiddick, Martha's Vineyard (MA Audubon, 2005b). Additionally, for the period of 1980 to 1997, the National Marine Fisheries Service (NMFS) has record of four green turtle strandings on the shorelines of Cape Cod Bay, and one stranding was reported in Nantucket Sound along the northern shoreline of Nantucket (NMFS, unpublished data) (see Figure BA-4). Of all the sea turtle strandings reported on Figure BA-4, the green sea turtle occurred the least, supporting other evidence that it is the least likely to occur in the area of the proposed action, given its stronger preference for more tropical areas.

Sea turtle strandings in New England waters are most likely caused by cold stunning (Morreale *et al*., 1992; Matassa *et al*., 1994). As with most marine turtles, prolonged exposure of green turtles to water temperatures below 50 ^{o}F (10 ^{o}C) (Shaver, 1990), may result in dormancy, shock, and death. In the cold water, the juveniles have a harder time maintaining an elevated body temperature and getting out of the bays and into warmer water than larger, adult turtles. In addition to cold stunning, the major sources of mortality of green turtles in United States waters are caused by anthropogenic activities which include the following: the incidental bycatch of turtles by various fisheries methods including shrimp trawls, gillnet fisheries and hook and line fishing; entanglement in ghost fishing gear and marine debris; entrapment in power plants' saltwater intake infrastructure; oil spills and the explosive removal of offshore oil platforms; and ingestion of marine pollutants including debris, pesticides, metals, and polychlorinated biphenyls (PCBs) (Thompson, 1988; NOAA, 2002; Seminoff, 2004; NMFS & USFWS, 1991).

Degradation of both nesting beach habitat and marine habitats also play a role in the decline of the green sea turtle. Nesting habitat degradation results from activities such as beach erosion, beachfront development; beach armoring and re-nourishment, beach raking, cleaning, and maintenance; the operation of recreational equipment and vehicles on the beach; sand extraction; the presence of exotic and invasive beach vegetation; and predation by raccoons, foxes, coyotes, ants, and ghost crabs. Habitat degradation in the marine environment results from dredging, increased contamination from coastal development, marina construction, and increased levels of recreational and commercial boat traffic. The presence of lights on or adjacent to nesting beaches can also alter the behavior of nesting adults and is potentially fatal to emerging hatchlings as they are attracted to light sources and drawn away from the water (USFWS, 2002; NOAA, 2002; Seminoff, 2004; NMFS & USFWS, 1991).

Green turtles mortality is also caused by the disease Fibropapillomatosis, or the development of tumors on the turtles' skin, scales, scutes, eyes, oral cavities, and internal organs. The tumors interfere with the turtles' ability to swim, eat, breathe, see, and reproduce; and lead to the eventual death of the infected reptile (USFWS, 2002; SCDNR, undated; Seminoff, 2004).

Figure BA-5 presents incidental observations of sea turtles made during late summer while performing surveys of birds from an airplane. Given the challenges of identifying sea turtle species from a moving airplane, the majority of the sightings are not species specific. During the 2002 to 2004 study period, sea turtles where observed within the area of the proposed action in Nantucket Sound, some of which could have been green sea turtles. However, within the bird aerial survey study area, the greatest number of observations occurred in the deeper water areas east of the area of the proposed action.

3.3 Avian Species

3.3.1 Piping Plover

3.3.1.1 Species Description

The piping plover is a small, light-colored shorebird with distinctive orange legs, a black neck band, and black brow during the breeding season. It forages in the wrack line, at the water's edge along coastal and island beaches, in mudflats, and sandflats. Piping plovers' primary foods are invertebrates including worms, tiny crustaceans and mollusks, insects, and other invertebrates (Haig and Elliot-Smith, 2004).

The United States Fish and Wildlife Service (USFWS) recognizes three distinct breeding populations; the Great Lakes population is designated as endangered, and the Northern Plains and Atlantic coast populations are designated as threatened (USFWS, 1996). The Great Lakes population breeds on the shorelines of Lake Superior, Lake Michigan, and Lake Huron (Haig and Elliot-Smith, 2004). The Northern Plains population breeds along prairie rivers and reservoirs from southeastern Alberta, to Manitoba, southwestern Ontario south to Colorado, Kansas, Montana, North and South Dakota, Nebraska, and Iowa (Haig and Elliot-Smith, 2004). The Atlantic Coast population nests along beaches in New Brunswick, Prince Edward Island, Nova Scotia, Quebec, Newfoundland, Saint Pierre and Miquelon (France), southern Maine, New Hampshire, Rhode Island, Massachusetts, Connecticut, New York, New Jersey, Delaware, Maryland, Virginia, and North Carolina (Haig and Elliot-Smith, 2004). The piping plover is divided into two subspecies based on geographic distribution, neck-band extent and brightness, and mitochondrial DNA (Haig and Elliot-Smith, 2004). Ornithologists continue to debate the validity of subspecies separation; however, the American Ornithologists' Union (AOU) maintains recognition of the two subspecies. Nonetheless, existing evidence indicates that the Atlantic coast plovers form a distinct breeding population.

Piping plover winter on beaches and mudflats from North Carolina to the Yucatan with large concentrations in Texas (Haig and Elliot-Smith, 2004). Islands in the Caribbean also serve as important wintering habitat (USGS, 2007). Band recovery results from birds banded during the breeding season indicate that most Atlantic Coast breeders winter along the southern Atlantic Coast, although some Massachusetts birds have been reported to winter in Texas (Haig and Elliot-Smith, 2004). Evidence suggests that most of the Northern Plains population winters on the Gulf Coast, and most Great Lakes breeders winter south along the Atlantic (Haig and Elliot-Smith, 2004). Winter studies of marked birds indicate that they generally return to the same wintering ground each year (Nichols and Baldasarre, 1990, Haig and Elliot-Smith, 2004, USFWS, 1996).

Over the past fifty years, the historical breeding ranges of the Atlantic Coast piping plover populations have decreased. Plovers no longer breed on the Gaspe Peninsula, Quebec or on the North Shore of Quebec (Haig and Elliot-Smith, 2004). In the late 1800s, over-hunting due to the hat trade was a factor contributing to the historical decline of piping plover (USFWS, 1996), as well as habitat loss (USFWS, per communication). More recent population decline is attributed to human recreational activities and shoreline development, which has resulted in habitat loss and decreased productivity of breeding pairs. Increased predation of eggs and chicks is another contributing factor to decline (Haig and Elliot-Smith, 2004). High tides and frequent storms resulting in the destruction of nests and beach erosion are also factors (Haig and Elliot-Smith, 2004).

The information included in this biological assessment has primarily been derived from data describing the Atlantic Coast piping plover. However, minimal information derived from observations of the Great Lakes and Northern Plains populations has been included. For some topics discussed in this document, more information is available regarding the behavior and physiology of interior piping plover that is not available for Atlantic Coast birds. In order to fill the data gaps that exist regarding the Atlantic Coast plover, this document considers interior plover data as an alternative to no information. Additionally, some interior nesting birds may fly east before traveling south to their wintering grounds (Haig and Elliot-Smith, 2004); therefore, there is a potential for a few interior birds to also occur at locations along the Atlantic Coast.

3.3.1.2 Life History

3.3.1.2.1 Breeding Season

Arrival and Courtship

Male piping plovers have been observed arriving at breeding sites in Massachusetts as early as March 15, followed by females as early as March 18 (MacIvor, 1990). By late-April, the ratio of male to females at beaches in Massachusetts are 3:4 and are nearing 1:1 by July (MacIvor, 1990). Males begin to set up territories by early April. Cairns (1982) reported instances of breeding site fidelity in piping plovers in Nova Scotia.

Piping plovers are primarily monogamous. Most birds retain the same mate throughout the breeding season but often change mates between years (Haig and Elliot-Smith, 2004). At the beginning of courtship, males undertake flights and vocalizations over breeding territories to advertise their availability to females. These displays could occur at elevations as high as 33 ft (10 m), but are restricted to nesting beaches (Report No. 4.2.9-1). Frequency and duration of the display decreases once a female begins to lay eggs, although males occasionally perform displays during the rest of the breeding cycle (Cairns, 1982). Unpaired males may continue to perform aerial displays until mid-summer, or until they disperse south. Nest-scraping rituals occur during courtship and just prior to copulation (Haig and Elliot-Smith, 2004). A courting male will call and walk about his territory conducting a series of movements that demonstrate nest-scraping. Following nest-scraping, a male may stand in a scrape with a female nearby and perform several head-tilt displays accompanied by stomping (Cairns, 1982). Females also dig scrapes, but less conspicuously than males. The pair may dig several scrapes during courtship, but eventually one scrape will be chosen as the nest site. It typically takes five to ten days for a pair to select a single scrape, to which a nest lining is added during courtship (Haig and Elliot-Smith, 2004).

Nesting and Brood-rearing

Piping plover mainly create nests on open sand or gravel beaches that are sparsely vegetated (Haig and Elliot-Smith, 2004). Nest sites are characterized by open sand, gravel, or shell-covered substrates, often close to small clumps of evenly distributed vegetation or near large objects (e.g., stones, logs), above the high water mark (Cairns, 1982, Haig and Elliot-Smith, 2004). Sites close to ephemeral pools, salt-ponds, or bays may be associated with increased fledging success (Goldin and Regosin, 1997; USFWS, 1996).

Piping plover copulate throughout the egg-laying period. In Massachusetts, the period of first egg-laying for initial nesting attempts has ranged from April 20 to June 18 (MacIvor, 1990). The first egg-laying period in renesting attempts ranges from May 17 to July 25 (MacIvor, 1990). The typical clutch size is four eggs; however, late initiated nests may only have three eggs. A female may lay an egg every other day, or more frequently for some pairs. The average clutch completion period has been found to be 8 days in Massachusetts, ranging from 5 to 12 days (MacIvor, 1990). Nests are generally not incubated until the clutch is complete (MacIvor, 1990), during which time males are very attentive and guard their mates (Haig and Elliot-Smith, 2004). A data comparison among nests in North Carolina, Rhode Island, and Massachusetts indicated complete initial clutches peak in all three locations between April 30 and May 7 (USFWS, 1996).

Females may lay several clutches (up to 5 per season) if nests are predated, inundated by the tide, or abandoned due to a disturbance. A female in Massachusetts was reported to have laid 19 eggs in one season (MacIvor, 1990). Renesting may occur as soon as 5 days or after 10 days after the loss of the first clutch (MacIver, 1990). Piping plovers will usually raise and fledge one brood per year; very rare cases have been reported where two clutches were brooded (Haig and Elliot-Smith, 2004). Renesting can result in late incubation periods, extending into July in Massachusetts during some years (MacIvor, 1990). Both sexes incubate the clutch. Eggs, therefore, are usually covered by an adult, unless a potential predator approaches, and the attending adult leaves the nest to lure the predator away by feigning an injury (Cairns, 1982). In warm weather, eggs may be left exposed for several minutes while the adult forages close by (Haig and Elliot-Smith, 2004). Males exhibit intense territory and mate defense during incubation, especially if an unpaired male approaches.

Management practices, including the use of predator exposures, are associated with increases in hatching and fledging success rates (MacIvor, 1990). A clutch is incubated, on average, for a period of 27.4 days, ranging from 25 to 31 days in Massachusetts (MacIvor, 1990). In Massachusetts, hatching dates have ranged from May 26 to July 31, with the majority of nests hatching before the beginning of July (MacIvor, 1990). The period between hatching of the first chick and the last chick of a clutch can extend between 5 to 42 hours, although most of the last chicks emerge within 10 hours (MacIvor, 1990). The downy chicks are precocial and depart the nest to forage within hours of hatching. Chicks remain in the vicinity of their parents while foraging and are periodically brooded by either adult. Chicks younger than 20 days spend the majority of their time feeding (Haig and Elliot-Smith, 2004) and typically triple their weight within two weeks of hatching. If chicks do not achieve 60 percent of their tripled birth weight within 12 days of hatching, they are unlikely to survive (Cairns 1977 *as cited by* USFWS 1996). On ocean beaches, young chicks forage in wrack lines. Adults will vocalize the presence of a potential predator, and chicks will either freeze-up or take cover in vegetation. Chicks will begin to visit the inter-tidal zone to forage as they approach fledgling status. Foraging occurs throughout the day, and at night. Brooding adults will alternate guarding while the chicks forage. When both parents are tending a brood, one may lead the chicks away from a potential predator while the other adult feigns an injury (Haig and Elliot-Smith, 2004).

Both parents usually brood and tend to chicks after hatching for a minimum of 34 days; however, females may desert broods after 5 to 17 days after hatching, while males remain with the young until they fledge (Haig and Elliot-Smith, 2004; MacIvor, 1990), although this behavior has only been reported on 5 occasions in Massachusetts. After such abandonment in Massachusetts, females have been observed at beaches as far as 10 km from their nest sites foraging with other plovers (MacIvor, 1990). Broods typically remain within the nesting territory until fledging; however, some adults with young have been observed as far as 0.3 to 1.8 km from the territories (MacIvor, 1990). The chicks may reach fledgling status (ability to fly greater than 15 m) after 25 to 34 days in Massachusetts (MacIvor, 1990). In Massachusetts, chicks have fledged as early as June 30 and as late as August 29 (MacIvor, 1990). Telemetry data gathered in North Dakota suggests that juveniles may travel more than 32 miles (50 km) within a few days of being able to fly (Haig and Elliot-Smith, 2004).

Productivity data (the mean number of chicks fledged per breeding pair per year) is variable among breeding populations and locations. The destruction of nests by storms and high tides, legal and illegal vehicle activity on beaches, as well as predation of eggs and chicks, has limited plover productivity along the Atlantic Coast. Table 2 shows the preliminary productivity estimates for Atlantic U.S. and Canada breeding pairs from 2003 to 2006. In Massachusetts, gulls, feral cats, dogs, falcons, red fox (*Vulpes vulpes*), striped skunk (*Mephitis mephitis*), and American crow (*Corvus brachyrhnchos*) have been known to take chicks (MacIvor, 1990).

Table 2. Piping Plover Productivity Estimates (number of chicks/pair) for the Atlantic Coast, 2003-2006 (USFWS, 2008)				
	2003	**2004 a/**	**2005***	**2006**
U.S.	1.24 (1287)	1.40 (1379)	1.20 (1383)	1.30 (1,370)
Canada	1.62 (219)	1.93 (223)	1.82 (192)	1.82 (219)
a/ Preliminary estimate. Parentheses indicate the number of breeding pairs on which productivity estimates are based.				

3.3.1.2.2 Migration

Information regarding Atlantic Coast piping plover migration routes and stop-over sites are based on available observations at breeding and stopover locations. Although detailed information about the exact migration routes for the population is incomplete (USFWS 1996), general migration patterns are available. Northern interior breeding birds leave breeding locations as early as late June or early July, occasionally earlier if adverse weather destroys initial nests (Haig and Elliot-Smith, 2004). Plovers may depart for fall migration as late as September if they have late-hatching nests (Haig and Elliot-Smith, 2004). In Massachusetts, birds depart breeding sites by late-August (Haig and Elliot-Smith, 2004; O'Brien *et al.,* 2006). Peak numbers of adults pass through the mid-Atlantic and Gulf coasts from mid-July to mid-August; peak numbers of juveniles pass through New Jersey in August, through Virginia in September and October; and through Texas in October and early November; some late moving juveniles will remain along the mid-Atlantic into November or December (O'Brien *et al.,* 2006). Generally, females will leave first, followed by unpaired males, then males with fledglings, then unaccompanied juveniles (Haig and Elliot-Smith, 2004).

Migration stop-overs occur largely at beaches that are predominantly mudflat (Haig and Elliot-Smith, 2004). When moving south in the fall, small groups of Atlantic birds are presumed to follow the coastline and may stop at several places before reaching their wintering destination (Haig and Elliot-Smith, 2004; USFWS, 1996). Migrants along the Atlantic Coast are presumed to follow a 'narrow' path along the coast; observations of plovers away from coastal beaches (inland or offshore) during migration are rare (USFWS, 1996).

There have been observations of concentrations of what were assumed to be pre-migratory staging plovers at breeding locations along the Atlantic Coast (USFWS, 1996). Some mid-coast sites experience larger numbers of plovers during fall migration than during the breeding season or the winter, suggesting that at least some Atlantic Coast birds use stop-over locations (Haig and Elliot-Smith, 2004). Flocks as large as 100 birds have been observed at Cape Lookout, North Carolina (Haig and Elliot-Smith, 2004). Other locations in North Carolina that have experienced large flocks of migrants include Oregon Inlet, Ocracoke Inlet/Portsmouth Flats, and New Drum Inlet, within the Cape Hatteras National Seashore (USFWS, 1996). In Massachusetts, South Beach, Chatham, Monomoy Island, and other beaches have been identified as fall stop-over areas that experience numbers of migrating plovers (USFWS, 1996). Eel Point on Nantucket has been identified as a staging area for pre-breeding piping plover (USFWS, 1996). In general, the birds congregate at stop-over sites in large groups of birds, presumably traveling in small flocks consisting of three to six birds, but sometimes up to as many as 15 birds (Haig and Elliot-Smith, 2004). Stop-over observations are not as well documented in the spring as in the fall but northward movements are presumed to be similar to fall movements (Haig and Elliot-Smith, 2004). Arrival to New England and the Maritime Provinces occurs between mid-April and mid-May (Haig and Elliot-Smith, 2004).

Most interior Canada and U.S. breeding birds are presumed to make non-stop migrations overland to wintering grounds on the Gulf of Mexico or the Atlantic Coast (Haig and Elliot-Smith, 2004, Haig and Plissner, 1993). Most interior birds are anticipated to fly south-southeast in the fall; however, very rare observations suggest that some inland birds may fly east to reach the Atlantic Coast, then fly south to the wintering grounds (Haig and Elliot-Smith, 2004). Inland birds' spring movements are also expected to be similar to fall movements (Haig and Elliot-Smith, 2004).

There have been no reported sightings of piping plovers in mid- or long-distance flight anywhere along the Atlantic coast (A. Hecht, personal communication). Sightings away from inland or offshore outer beaches are rare (USFWS, 1996). Observations of color-marked birds indicate that some Atlantic Coast birds cross over to Gulf Coast wintering grounds; however, the actual routes are unknown (O'Brien *et al*., 2006; USFWS, 1996). Sightings of plovers at islands in the Caribbean as far as Bermuda and the West Indies indicate that piping plover do undertake long-distance offshore movements (USFWS, 1996). To develop a more complete understanding of piping plover migration, additional information would be needed about migration patterns in a variety of weather conditions during both day and night, including: flight heights; flight patterns (e.g., coastal, off-shore, well off-shore); flight directions; and additional important stop-over habitats (USFWS 1996).

3.3.1.2.3 Survivorship

Plovers may breed during their first year and all birds are thought to have bred by their fourth year (Calvert *et al.,* 2006). Evidence suggests that many first year birds return to the vicinity of their natal sites for the breeding season (Haig and Elliot-Smith, 2004).

Plovers have been known to live as long as 5 to 11 years of age. Sources of mortality for eggs, chicks, and adults include predation by raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), Virginia opossum (*Didelphis virginiana*), red fox (*Vulpes vulpes*), mink (*Mustela vison*), ermine (*M. ermina*), coyote (*Canis latrans*), domestic dog (*C. familiaris*), domestic cat (*Felis domesticus*), old-world rat (*Rattus* sp.), American crow (*Corvus brachyrhynchos*), Northern raven (*Corvus corax*), and several species of gull (*Larus* spp.) (Haig and Elliott-Smith, 2004). Migrating peregrine falcon (*Falco peregrinus*) are occasional predators of piping plover (USFWS, 1996). On the wintering grounds, hurricanes, extreme cold weather, and oil spills are potential sources of mortality (USFWS, 1996). Estimated mean annual survival rates for adults range from 67 to 83 percent, and 41 to 48 percent for chicks (USFWS, 1996).

3.3.1.3 Population Dynamics

There are no comprehensive estimates of historical population numbers prior to 1980 (USFWS, 1996). Over-hunting in the late 1800s was a major factor contributing to the decline of the historical piping plover population (USFWS, 1996). Since 1918, the take of piping plovers and other migratory birds has been prohibited by the Migratory Bird Treaty Act. The more recent decline of the Atlantic Coast piping plover population is attributed to habitat loss and degradation, disturbances caused by humans and pets, and increased predator populations in coastal environments (USFWS, 1996). Excessive disturbance may cause the parents to flee the nest, exposing eggs or chicks to the hot sun or predators. Vehicle traffic can destroy unprotected nests and can crush chicks (USFWS, 1996). High disturbance levels around nest sites can also result in the abandonment of nests, and ultimately, decreased breeding success. Causing parents or juveniles to flush while foraging may stress juveniles enough to negatively influence critical growth and development (*See Effects of the Action, Disturbance for discussion of disturbance distances related to habitat loss*).

Along the Atlantic Coast, commercial, residential, and recreational development have decreased the amount of coastal habitat available for piping plovers. Development such as seawalls and jetties, and the manipulation of beach dunes, has resulted in beach erosion and the degradation of nesting habitat (USFWS, 1996). Developments near beaches provide suitable habitat for predators such as raccoons, skunks, and foxes. Domestic and feral cats, often associated with developed beaches, have been identified as a significant source of mortality for piping plover eggs and chicks (Winter and Wallace, 2006; Melvin *et al.,* 1991 *as cited by* Haig and Elliot-Smith, 2004). Extreme tides and storm tides can inundate nests; however, plovers will re-nest after destruction of nests early in the breeding season. Unusual stochastic events, such as hurricanes, can impact hundreds of young-of-the-year and adults. Storms can also, over a period of time, positively affect local piping plover populations by leveling dunes and creating suitable nesting habitat (Wilcox, 1959; USFWS, 1996). Beach development and stabilization activities, dredging, recreational activities, and pollution are factors that are impacting the plover population on wintering grounds (USFWS, 1996). There are additional unknown sources of mortality experienced during migration or on the wintering grounds (Root *et al.,* 1992; Calvert *et al.,* 2006).

During the past 50 years, breeding piping plovers have disappeared from several places in the Midwest and a few places on the Atlantic Coast, specifically the Gaspé Peninsula and the North Shore of Quebec (Haig and Elliot-Smith, 2004). The Atlantic Coast population has gradually increased, particularly in the central part of the range (New England and New York), mainly due to management practices. Conversely, numbers have declined in eastern Canada and along the southern edge of the range in North Carolina. Numbers of piping plovers continue to increase in the Great Lakes, but this population segment represents less than two percent of the species and most historic sites have not been re-colonized, except those in Wisconsin (Haig and Elliott-Smith, 2004).

3.3.1.4 Status and Distribution

On January 10, 1986, the piping plover was listed as endangered and threatened under provisions of the Endangered Species Act (50 FR 50726 50734). USFWS designated the Great Lakes population as endangered and the Atlantic Coast and Northern Great Plains populations as threatened. The 1991 international census documented 5,482 total piping plover (Plissner, 1993). The 2001 total population estimate was 5,945 total birds (Haig and Elliot-Smith, 2004). Preliminary results from the 2006 international census conducted on the breeding grounds resulted in approximately 3,800 birds counted in the U.S., Mexico, and the Caribbean on the wintering grounds (USGS, 2007).

The Atlantic Coast population nests along beaches in New Brunswick, Prince Edward Island, Nova Scotia, Quebec, Newfoundland, Saint Pierre and Miquelon (France), southern Maine, New Hampshire, Rhode Island, Massachusetts, Connecticut, New York, New Jersey, Delaware, Maryland, Virginia, and North Carolina (Haig and Elliott-Smith, 2004).

Since being listed as federally threatened in 1986, the Atlantic Coast population has increased from 800 pairs to approximately 1,350 pairs in 1995 (however, a portion of reported increases from 1986 to 1989 in North Carolina, New York, and New Jersey were attributed to increases in survey effort) (USFWS, 1996). The current estimated number of Atlantic Coast breeding pairs for 2006 is 1,743 (Table 3).

Table 3.
Estimates of the Number of Atlantic Coast Breeding Pairs of Piping Plovers 1996-2006 (USFWS, 2008)

	1996	1997	1998	1999	2000	2001	2002	2003	2004*	2005*	2006
U.S.	1162	1187	1168	1156	1207	1280	1415	1420	1423	1415	1370
Canada	186	197a/	212	240	231	245	275	256	237b/	217	219
Atlantic Coast	1384	1384	1380	1396	1438	1525	1690	1676	1660	1632	1589

*Numbers represent preliminary estimates.

a/ Used 1996 Newfoundland estimate of 11 pairs because 1997 estimate unavailable.

b/ Two sites totaling 10 pairs in 2003 not included in estimate.

The Atlantic Canada population has generally declined in recent years despite relatively high productivity (Table 2, Table 3, Figure BA-6). The Canadian Wildlife Service reports that banding studies are showing relatively low rates of returns of second-year birds, even following years of high productivity, suggesting mortality outside of the breeding season (USFWS, 1996). The Atlantic U.S. population has generally been increasing over the past 10 years, likely due to intensive management practices (Figure BA-6).

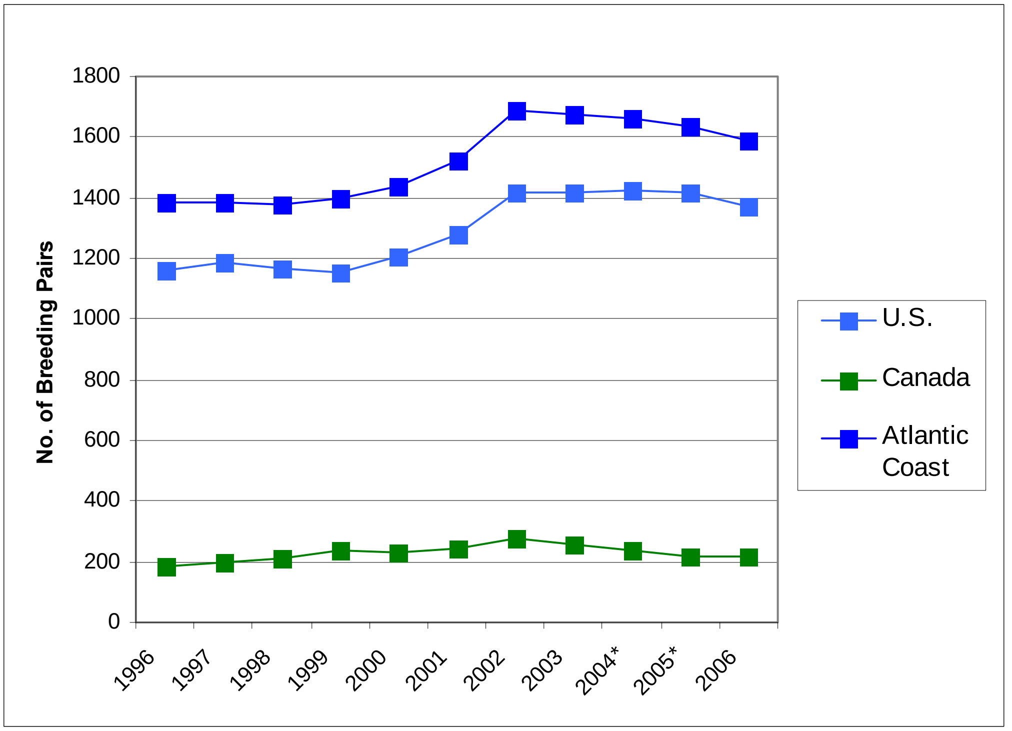


Figure BA-6.
Estimates of the number of Atlantic Coast breeding pairs of piping plover 1996-2006 (USFWS, 2008)*preliminary estimates

The Atlantic Coast recovery goal is 2,000 pairs maintained over a period of at least 5 years, including 1,600 breeding pairs for the U.S. (New England 625 breeding pairs; New York and New Jersey 575 breeding pairs; and Delaware, Maryland, Virginia, and North Carolina 400 breeding pairs), and 400 breeding pairs for Atlantic Canada (USFWS, 1996). Another recovery objective is a five-year average productivity of 1.5 fledged chicks per pair in each of the four recovery units (USFWS, 1996). Atlantic Canada has exceeded the average productivity goal; however, the number of breeding pairs does not reflect an increase. The Atlantic Coast population is approaching this recovery goal mainly due to intense annual management activities (USFWS, 1996).

As part of the management practices being implemented on behalf of the plover, on June 12, 2001 a proposed rule for the designation of critical habitat was published for the Northern Great Plains breeding population. On May 3, 2001, USFWS designated critical habitat for endangered Great Lakes birds. The final rule designating critical habitat for the wintering population of the piping plover was published in the Federal Register on July 10, 2001. There have been no critical habitat designations established for Atlantic Coast breeding areas; however, protection of wintering grounds provides benefits to the Atlantic Coast breeding population. The USFWS designated 137 areas along the coasts of North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas as critical habitat for wintering populations. This includes approximately 1,798.3 mile (2,891.7 km) of mapped shoreline and approximately 165,211 acres (ac) (66,881 hectares (ha)) of mapped area along the Gulf and Atlantic coasts and along interior bays, inlets, and lagoons (USFWS, 2001).

3.3.2 Roseate Tern

3.3.2.1 Species Description

Roseate terns (*Sterna dougallii*) are distinguished from similar tern species by their overall pale color and, during the breeding season, their long-forked tail 5.5 to 9 inch [14 to 23 cm]) and the rosy tinge to their abdominal feathers. Roseate terns are medium sized terns (13 to 16 inch [33 to 41 cm] in length) with a swift wing-beat during flight. During the breeding season for Atlantic Coast and Canada roseate terns, the base of the otherwise black bill becomes increasingly orange and the legs are orange. After breeding, the black cap is replaced by a black face mask and white forehead, the rosy tinge fades, and the tail becomes shorter after a molt. Roseate terns breed in colonies with other tern species along marine coasts and migrate long distances during the spring and fall (Gochfeld *et al.,* 1998). As of 1987 when the species became listed as Endangered in the U.S., the number of roseate tern colony sites had decreased from 30 historical nesting locations to a few major colony sites (USFWS, 1987). The narrowing of their breeding range is presumed to be influenced by displacement from nesting locations by gulls, loss of habitat, and the species' restrictive habitat requirements.

Breeding locations are currently in Novia Scotia; Quebec; the Gulf of Maine; Buzzards Bay, Cape Cod, Nantucket, and Martha's Vineyard in Massachusetts; and Eastern Long Island Sound, Gardiner's Bay, and Southern Long Island Sound in Connecticut and New York. There are three major colonies located along the Atlantic Coast and Canada that have, over the past 7 years, been inhabited by substantial portions of the population: Great Gull Island in New York, and Bird and Ram Islands in Massachusetts. These three colonies have represented over 80 percent of the population in recent years (RTRT, 2007).

3.3.2.2 Life History

3.3.2.2.1 Foraging

Roseate terns forage by plunge diving from heights ranging from 3.3 to 39.4 ft (1 to 12 m) for small fish, primarily sand eels (*Ammodytes americanus*) in New England, and sometimes take insects, small crustaceans, and squid (Gochfeld *et al.,* 1998). Roseate terns forage in mixed flocks with other terns and gulls over shoals, shallow water, and schools of predatory fish where bait fish are pushed to the surface (Heinemann, 1992). They sometimes seldom forage over diving cormorants that chase bait fish to the surface and commonly have been known to kleptoparasitize fish from other terns at breeding colonies (Heinemann, 1992). During the breeding season, roseate terns will travel as far as 16 to 19 miles (25 to 30 km) from the colony to access foraging habitat and are presumed to regularly return to productive foraging locations (Heinemann, 1992; USFWS, unpubl. Data, 1995).

3.3.2.2.2 Pre-breeding Period

The Northeast and Atlantic Canada population of roseate terns travels long-distances in the spring and fall, mainly over the ocean (Gochfeld *et al.,* 1998). During spring migration, roseate terns travel in large flocks, often mixed with common terns (*S. hirundo*). Northeast birds arrive and some aggregate in Nantucket Sound before dispersing to breeding locations in the Sound, Buzzards Bay, Maine, and Canada. An estimated 10 to 12 percent of the roseate population travels north of Nantucket Sound, while 88 to 90 percent move south and west to locations in Buzzards Bay, Long Island Sound, and to Falkner Island in Connecticut (Spendelow *et al*., unpublished). Pair bonds are formed just before arrival at breeding colonies or during territory establishment (Gochfeld *et al.,* 1998). Bonds continue through the breeding season and can end after a single season or last for multiple seasons (Gochfeld *et al.,* 1998). Roseate terns return to breeding grounds in the Northeast and Atlantic Canada from late-April to mid-May and can occupy the colony site for up to 3 weeks before egg laying (Gochfeld *et al.,* 1998).

3.3.2.2.3 Nesting Period

Roseate terns prefer nest sites on rocky island beaches, barrier beaches, or salt marsh islands that provide some vegetative or debris cover. They require locations that are protected from human disturbance and predation from gulls or mammals. Roseate terns share nesting colonies with common terns, benefiting from the protection of their more vigorous defensive behavior (Gochfeld *et al.,* 1998). Roseate terns exhibit strong colony site fidelity though there is some individual movement among colony sites of the northeastern meta-population (the Northeast and Atlantic Canada) (Lebreton *et al*., 2003). Data suggest that 5 percent of breeding individuals move between northeast colonies among years (Nisbet and Spendelow, 1999).

Observations made in the vicinity of Bird Island indicate that, during pre-incubation, roseate terns spend 5 to 8 percent of daylight time in territorial defense, 20 to 30 percent of the time in courtship behavior at the territory, 20 percent of the time resting on the territory, and for the remainder of daytime, males forage to courtship-feed females (Gochfeld *et al.,* 1998). Females usually remain at the breeding territory but may join the male at feeding areas where courtship feeding also occurs (Gochfeld *et al.,* 1998). Roseate terns undertake elaborate courtship flights in the vicinity of breeding grounds that involve multiple individuals and range from heights of 98 to 980 ft (30 to 300 m) (Gochfeld *et al.,* 1998). Observations of courtship aerial displays have been made at foraging locations (I. Nisbet, pers. comm.; C. Mostello, pers. comm.; M. Amaral, pers. comm.). These displays have rarely been seen at foraging locations, but this behavior has not been studied for terns foraging offshore (M. Amaral, pers. comm.). During courtship flights, three to eight birds may ascend rapidly together in wide circular paths, making rapid, jerky wing-beats. The two leading birds, after reaching their maximum height, glide close together, then glide downward with the female swaying above or ahead of the male (Gochfeld *et al*., 1998). Most courtship display behavior and copulation takes place on the edge of the colony and rarely at nest sites, however, it also occurs at resting locations far from the colony (Gochfeld *et al.,* 1998).

Observations made at Bird Island in Buzzards Bay in 2006 indicated that roseate terns had arrived at the colony site by May 4 (Causey and Mostello, 2006). The first egg laid (by a roseate tern) was May 18 in 2006 on Bird Island (Causey and Mostello, 2006). The period of egg-laying is variable among years and usually extends into the summer (due to loss of eggs or chicks from first clutches). The timing of initiation of egg-laying has been found to be largely dependent on the availability of prey (Heinemann, 1992). The availability of prey influences the ability of females to build up their nutritional reserves prior to egg-laying (Safina *et al*., 1988). In 2006, the egg laying period extended from May 18 to July 9 on Bird Island (Causey and Mostello, 2006).

Eggs are laid in nest 'scrapes' in substrates of sand, shell, or rock. Spacing of nests among breeding pairs at colony sites is dependent on the vegetative and debris cover available and nests have been reported as close as 11.8 to 19.7 inch (30 to 50 cm) (Gochfeld *et al.,* 1998). Clutch sizes range from one to four eggs (usually 1 or 2 eggs for male-female pairs; clutches of 3 or 4 eggs involve the nest of 2 or more females that have mated with a male(s) and have each laid an egg(s) in the nest, and these females share incubating responsibilities at this nest). For male-female pairs, eggs are laid over a period of two to four days. On Bird Island in 2006, the median date of clutch initiation was May 26, nine days earlier than it was in 2005 (June 4) (Causey and Mostello, 2006).

Both male and females share incubating and foraging responsibilities and rear a single brood per season. During the breeding season, birds will depart the colony to forage at early dawn. The heaviest foraging occurs in the first three hours of light, and again in the mid-afternoon (Gochfeld *et al.,* 1998). Roseate terns will travel as far as 16 to 19 miles (25 to 30 km) from the colony to access foraging habitat and are presumed to regularly return to productive foraging locations (Heinemann, 1992). During preincubation periods, roseate terns budget more than 40 percent of their daylight hours commuting to forage or actively foraging (Gochfeld *et al*., 1998). During incubation, males invest 47 percent of daylight hours incubating the nest, and females invest 53 percent of their daylight hours incubating. The remainder of the birds' day is invested in resting, territorial defense, and primarily, foraging commutes or active foraging. During commutes to forage, roseate terns travel at an average rate of 37.4 km/h (Gochfeld *et al*., 1998). A study was conducted at Bird Island to investigate the return rates at 10-minute intervals of roseate terns that had apparently commuted to foraging locations. Return rates varied throughout the breeding season and peaked (15 to 23 birds/min in 1990, and 30.7 birds/min in 1991) during the third week of June into mid-July (Heinemann, 1992). The results indicate that the frequency of tern foraging commutes is highest during the breeding season after most chicks have hatched. Due to the species' unbalanced sex ratio, which is 45 percent male (Report No. 5.3.2-5), female-female pair bonds are estimated to account for about 7.8 to 12 percent of nests at Bird and Falkner Islands (Nisbet and Spendelow, 1999; Szczys *et al*., 2005). Females that share incubation responsibilities with other females may mate with already paired males and usually attend larger clutches (3 to 4 eggs) (Gochfeld *et al.,* 1998). However, infertility and incubation problems resulting from the large clutches of female-female pairs contribute to the low hatching success of these pairs (40 to 50 percent hatching success). There is a 98 percent hatching success among male-female pairs (Nisbet and Spendelow, 1999).

A second clutch, usually of only one egg, is often initiated by breeding pairs if eggs or chicks are lost. After an incubation period of about 23 days, the semi-precocial chicks hatch. In 2006, the first roseate tern chick to hatch at Bird Island hatched on June 11 (Causey and Mostello, 2006). The median date of the first wave of hatching was June 18 (compared to June 28 in 2005) (Causey and Mostello, 2006). Chicks require 22 to 30 days before fledgling. The first observation of fledging from a chick hatched at Bird Island in 2006 was July 5 (Causey and Mostello, 2006). Nesting success is seasonally variable and is generally lower for later clutches (nests initiated in late-June and July). Birds that nest later typically produce fewer fledglings.

Additionally, the first chicks to hatch from a clutch have better survival rates (97 percent) than the second chicks to hatch (30 to 60 percent) (Nisbet and Spendelow, 1999). The mean annual productivity (fledglings per breeding pair) for the U.S. population (productivity data is unavailable for breeding sites in Canada) from 2000 to 2007 is 1.150 (RTRT, 2007). Figure BA-7 shows the variable productivity trends of the three major Northeast colonies from 2000-2007. Productivity is limited by egg and chick predation or mortality (usually caused by starvation). Predation of eggs at Bird Island in 2006 was due to avian predators including gulls and ruddy turnstones (*Arenaria interpres*) (Causey and Mostello, 2006). If the adults depart nests due to disturbances or during storms (as observed in May 2006 at Bird Island [Causey and Mostello, 2006]) eggs and chicks may become vulnerable to predation. Chicks are most vulnerable to mortality for five days after hatching. Productivity is presumed to also be limited by the population's unbalanced sex ratio.

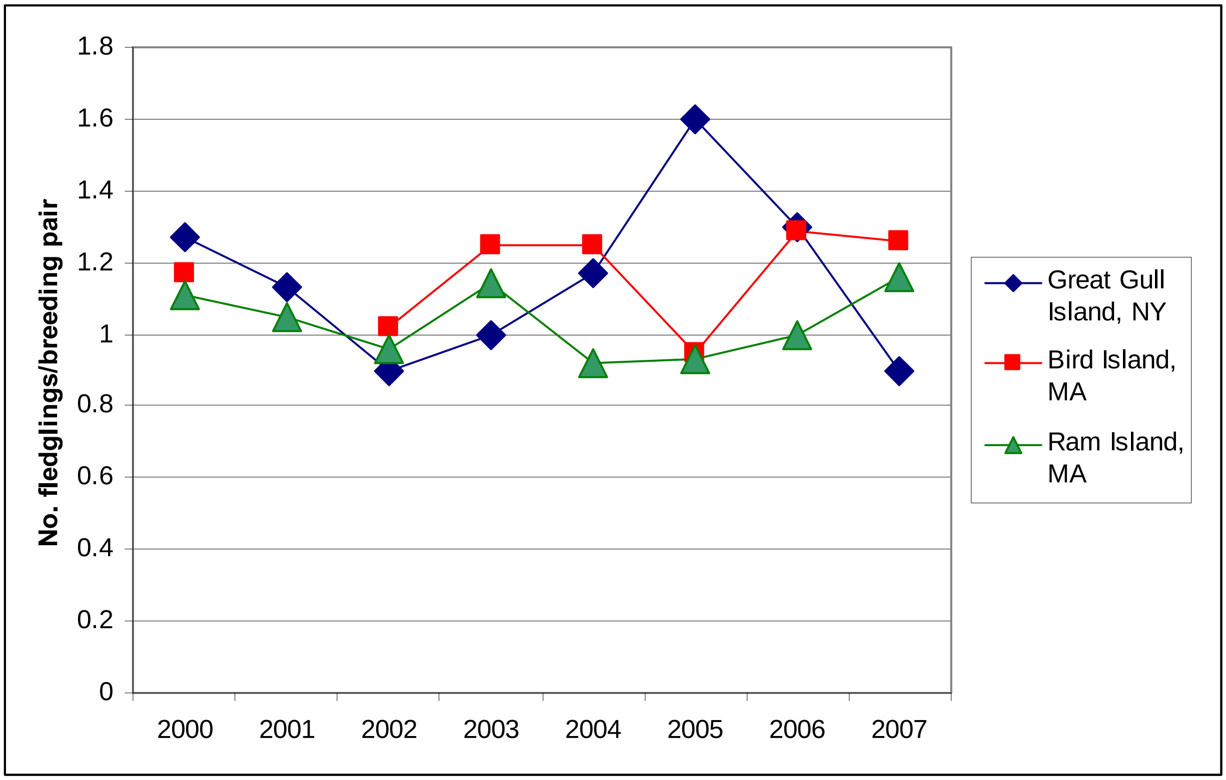


Figure BA-7.
Roseate tern productivity at Bird and Ram Islands in Massachusetts, and Great Gull Island in New York, 2002-2007 (preliminary 2007 estimates) (RTRT, 2007)

After the breeding season, the fledglings leave the colony with their parents and gather with other roseate terns at pre-migratory staging areas where they learn to forage and are fed and attended by their parents at least until migration (Gochfeld *et al.*, 1998; Shealer and Kress, 1994). A study investigating the efficiency of roseate tern fledgling foraging success determined that by the end of the staging period, roseate fledglings are not likely to be skilled enough as foragers to survive migration without parental care (Watson and Hatch, 1999). Therefore, parental care may extend through migration so that juveniles can learn advanced foraging techniques (Watson and Hatch, 1999). During fall migration, the terns travel in groups from post-breeding staging areas to the West Indies and South America (Gochfeld *et al.,* 1998).

3.3.2.2.4 Survivorship

Most roseate terns remain at the wintering grounds during their first summer. Some migrate north at the age of two and occur as non-breeders at breeding colonies (Nisbet and Spendelow, 1999). Most birds begin to breed at an age of three years, though few begin as early as two years; some wait until four years of age. Lebreton *et al.,* (2003) estimated that 1 to 4.5 percent of second year birds are recruited into the breeding population, while 100 percent of fifth and sixth year birds are recruited. Breeding usually occurs every year after initiation; however, it is presumed that some pairs do not breed during seasons with low food availability (Gochfeld *et al.,* 1998). Some individuals (mostly females) known to have nested in previous years were observed at nesting areas during seasons when they did not breed (Nisbet and Spendelow, 1999).

Studies conducted at four colonies in Connecticut and New York suggest that annual adult survival rates range from 74 to 84 percent. The survival rate from fledgling to first breeding was estimated at 20 percent at Falkner Island, Connecticut (Spendelow, 1991; Nichols *et al.,* 1990). Lebreton *et al.* (2003) estimated an annual survival probability of 85 percent (in the absence of unusual events such as the 1991 hurricane) of northeastern adults and an immature (over 2 years) survival probability of 0.38. Unusual weather events such as hurricanes can largely influence annual survivorship: as a result of Hurricane Bob in 1991, adult survival probability was estimated at 67 percent and immature (over 2 years) survival probability was estimated at 10 percent (Lebreton *et al*., 2003).

Adult mortality rates in the absence of predation are generally low during the breeding season; however great horned owl (*Bubo virginianus*), red fox (*Vulpes vulpes*), and Norway rat (*Rattus norvegicus*) have been known to take large numbers of adults (Gochfeld *et al.,* 1998; MDFW, unpubl. data), as well as mink (*Mustela vison*), raccoon (*Procyon lotor*), and peregrine falcon (*Falco peregrinus*) (C. Mostello, personal communication; MDFW, unpubl. data). Observations made at Bird Island in 2006 indicate that sources of adults found dead at the colony that year included: one death attributed to impact with the Bird Island lighthouse during a storm on May 15, one predated adult found on May 26, one adult found dead on June 5 with fishing line wrapped around its leg band and caught on vegetation, and two found in ponds (June 27 and July 1) on the island with no obvious sign of injury (Causey and Mostello, 2006).

Human predation on wintering grounds is presumed to sometimes present a significant source of adult mortality (Gochfeld *et al*., 1998). Males are presumed to have a lower survival rate than females (Kendall and Nichols, 2004). Roseate terns often live over 20 years (Gochfeld *et al.,* 1998). The oldest banded bird on record, banded as a chick in Massachusetts and recaptured in Brazil, was 25.6 years old (Gochfeld *et al.,* 1998).

3.3.2.3 Population Dynamics

In the late 1890s, due to the millinery trade, the northeastern population (Northeast and Atlantic Canada) began to decline from an estimated 8,500 breeding pairs to 2,000 breeding pairs. After the passing of the Migratory Bird Treaty Act in 1918, the population quickly recovered to roughly 8,500 breeding pairs in 1930, remaining stable until the 1950s. After 1978, 90 percent of the Northeast population was limited to four breeding colonies: Bird Island and Monomoy Island in Massachusetts; Great Gull Island in New York; and Falkner Island in Connecticut. The northeastern population of roseate terns formerly bred from Sable Island, Nova Scotia to Virginia, however, the birds no longer breed south of Long Island, New York, at former sites in Virginia, Maryland, or New Jersey. By 1978, the population had dropped to 2,500 breeding pairs (MNH&ESP, 1988).

Due to management activities after listing of the species in 1987, the population gradually increased until about 2000, despite a dramatic decline between 1991 and 1992, the year of Hurricane Bob (RTRT, 2007). From 2000 to 2006, the Northeast and Atlantic Canada breeding population generally declined for unknown reasons (despite a 9 percent increase in the Northeast breeding pairs between 2002 and 2003); the population increased substantially between 2006 and 2007 (Figure BA-8), demonstrating the unpredictability of this dynamic population. The recent increase is reflected in the total number of breeding pairs in the Northeast in 2007, which increased by 12.5 percent to 4012 pairs (C. Mostello, personal communication; RTRT, 2007). The Northeast and Atlantic Canada population is currently at 4,112 breeding pairs (RTRT, 2007)

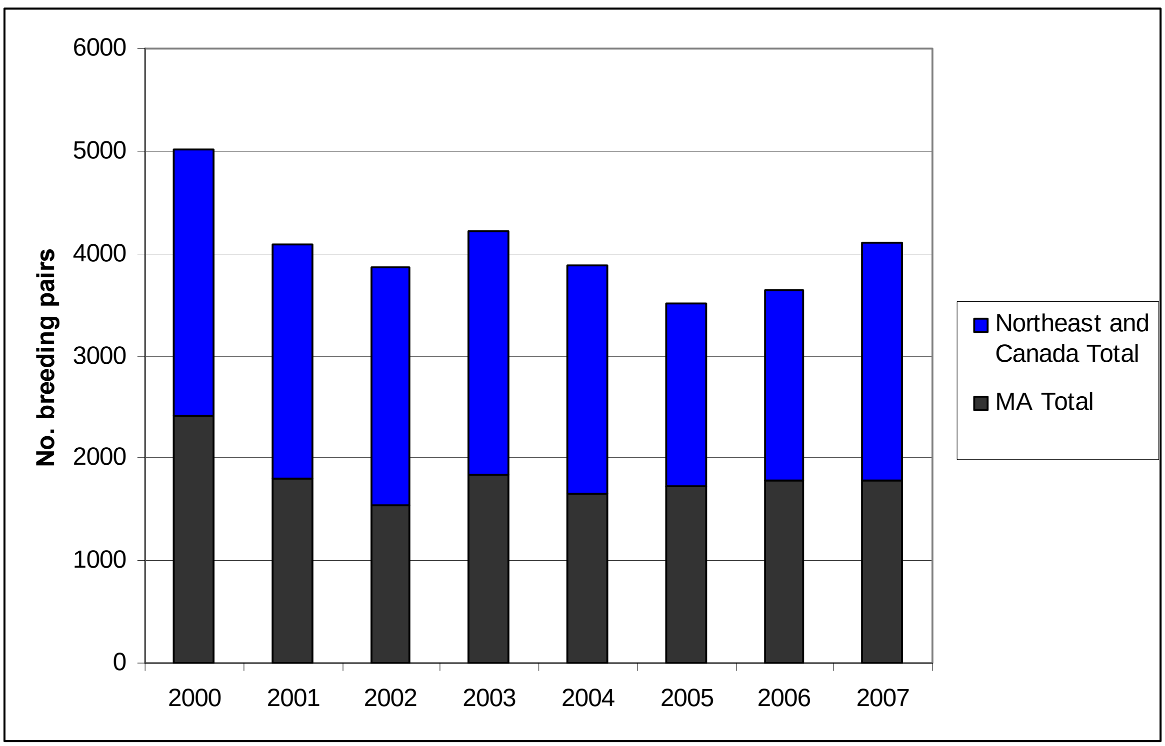


Figure BA-8.
Reported totals of roseate tern breeding pairs 2000-2007 (preliminary estimates) – Massachusetts, and Northeast and Canada population (RTRT, 2007)

3.3.2.4 Status and Distribution

Roseate terns were listed as Endangered by the U.S. Fish and Wildlife Service (USFWS) in the U.S. (Atlantic Coast south to Virginia) (USFWS, 1987). The Canadian population (Newfoundland, Nova Scotia, Quebec) of roseate terns was designated as Threatened by the Committee on the Status of Endangered Wildlife in Canada in 1985; as of 1999, roseate terns are listed as Endangered in Canada (Environment Canada, 2006). The Caribbean population, including the southern U.S. Atlantic Coast, Puerto Rico, and the U.S. Virgin Islands, are listed as Threatened (USFWS, 1987).

Factors contributing to past declines of roseate terns include loss of suitable nesting habitat caused by human coastal development and beach erosion, gull predation and competition at colony sites, low productivity due to decreases in food availability, and adult mortality at wintering grounds (Gochfeld *et al.*, 1998). The female biased sex ratio may also be a factor in productivity and past declines of breeding pairs (Gochfeld *et al.*, 1998). The cause(s) of the more recent general decline between 2000 and 2006 has not been identified, portraying that the dynamics of this population are complicated and difficult to predict, making current and long-term trends difficult to assess. The roseate tern's specific breeding habitat requirements, which include vegetative or debris cover, a lack of competitors or predators, and roseate terns' tendency to remain at previously productive colony sites, make it difficult for the birds to establish colonies at other locations.

Between 2000 and 2007, there have been 73 active and inactive breeding locations along the Atlantic Coast and Canada that have been monitored. Individual colony locations have ranged in size over the past 7 years from 0 to 2,047 breeding pairs (RTRT, 2007). Among these sites, 22 have not been active breeding locations since 1998, or earlier (RTRT, 2007). The number of breeding pairs at known nesting locations is highly variable among years; however, there are three major colonies located along the Northeast Atlantic Coast and Atlantic Canada that over the past 7 years have been inhabited by substantial portions of the population: Great Gull Island in New York, and Bird and Ram Islands in Massachusetts. In 2007, the Great Gull Island nesting pairs (1,636 total) represented 40 percent of the total number of breeding pairs reported in the U.S. and Canada combined (4,112 total); Bird Island pairs represented 24 percent of the total number of pairs; and Ram Island pairs represented 17 percent of the total number of breeding pairs (RTRT, 2007). Relatively smaller breeding colonies that have supported more than 20 confirmed nesting pairs in recent years include Country Island and The Brothers in Nova Scotia; Petit Manan Island, Eastern Egg Rock, and Stratton Island in Maine; Seavey Island in New Hampshire; Minimoy Island and Penikese Island in Massachusetts; Falkner Island in Connecticut; and Gardiners Island, Cartwright Island, and Goose Flat in New York (RTRT, 2007).

4.0 ENVIRONMENTAL BASELINE

4.1 Status of the Species within the Action Area

4.1.1 Whales

The three species of whales that have the potential to occur in the area of the proposed action's activities are highly migratory, with seasonal distribution in New England waters and a limited potential to occur year-round. Further, the potential for these whales to occur in Nantucket Sound is lessened by the limited presence of adequate food sources. Most whales are found in areas where their primary food source can be easily located. The bathymetric and oceanographic features identified above that favor dense aggregations of whale prey species are not developed in Nantucket Sound to the extent that they are farther north around Stellwagen Bank, Jeffreys Ledge, Browns and Bacaro Banks, and in the Great South Channel (Kenney and Winn, 1986). Therefore, the preferred foods of whales and the whales themselves occur in Nantucket Sound with far less abundance and frequency than in high-use areas farther north.

4.1.1.1 Humpback Whale

Humpback whales are present in New England waters in greatest abundances between June and September, with the potential to occur in Massachusetts waters from mid-March to the end of November (Payne and Heinemann, 1990; Sadove and Cardinale, 1993; NOAA Fisheries, 2005a). All age classes, including mother/calf pairs, are present during the summer. Smaller numbers, nearly exclusively solitary juveniles, frequently are observed in December and January.

The primary feeding grounds for humpback whales are located further offshore from Nantucket Sound so very few whales are sighted within the Sound itself. According to the Center for Coastal Studies (CCS) (CCS, 2006), humpback whales may pass through Nantucket Sound occasionally, but they are "simply not forming aggregations there."

4.1.1.2 Fin Whale

Fin whales are more common than other large whales in the temperate waters of the western North Atlantic, and may be present in Massachusetts waters mid- March to the end of November (Waring *et al.*, 2006; NOAA Fisheries, 2005a). New England waters provide important feeding grounds for fin whales, particularly in Jeffreys Ledge, Stellwagen Bank, and Cape Cod Bay (CeTAP, 1982). Very few whales are found in Nantucket Sound, even though the Stellwagen Bank feeding grounds are in adjacent offshore waters. Similar to humpback whales, Nantucket Sound does not support dense aggregations of fin whale prey species as other areas (Kenney and Winn, 1986). Therefore, the preferred foods of fin whales and the whales themselves occur in Nantucket Sound with far less abundance and frequency than in high-use areas farther north.

4.1.1.3 North Atlantic Right Whale

Right whales are a migratory species that may be found in New England waters between February and May, with peak abundance in late March (NMFS, 2005). The potential for the presence of right whales in Massachusetts waters exists from early December to the end of June (NOAA, 2005a). Feeding, nursing and mating behavior has been observed in Cape Cod Bay, and the Great South Channel provides important feeding and nursery grounds with peak abundances in spring (Schevill *et al*., 1986; Hamilton and Mayo, 1990; Kraus and Kenney, 1991; Marx and Mayo, 1992). As such, Cape Cod Bay and the Great South Channel have been designated Critical Habitat for the recovery of the North Atlantic right whale.

Although important seasonal feeding and nursery grounds for right whales are located further offshore from Nantucket Sound in the Great South Channel and Stellwagen Bank, very few whales have been sighted in Nantucket Sound. Nantucket Sound is too shallow and not productive enough in terms of copepods to support right whales (Kraus, 2006). No right whale surveys have targeted Nantucket Sound, though many ship-based and aerial surveys for great whales (including right whales) in North Atlantic waters pass over or through Nantucket Sound, including the CeTAP and POP surveys. Neither the North Atlantic Right Whale Consortium database nor NMFS data contain any records of right whale sightings in Nantucket Sound (Kenney, 2002; NMFS-NEFSC, 2002, unpublished data).

4.1.2 Sea Turtles

The four species of sea turtles that occur in the action area are highly migratory, and no individual members of any of the species are year-round residents of the action area. Incidental observations made during a 2002 to 2004 pre-migratory staging season survey of Nantucket Sound showed 115 sea turtles, of which only 14 were found within the area of the proposed action (MA Audubon, 2005a).

4.1.2.1 Kemp's Ridley Sea Turtle

The Kemp's ridley sea turtle is found mainly in the Gulf of Mexico, but juveniles may occur during the summer along the Atlantic seaboard from Florida to Long Island Sound, with some individuals occasionally visiting Cape Cod Bay, Massachusetts Bay and the Gulf of Maine (Lazell, 1980; Hildebrand, 1982). Juveniles may be found in northern waters from late May to mid-September primarily in shallow nearshore waters (Keinath *et al.,* 1987; Musick and Limpus, 1997). Most ridleys that remain in northern waters in the beginning of November are cold-stunned; however some may hibernate over winter in the nearshore sediments (Carminati *et al.,* 1994).

4.1.2.2 Leatherback Sea Turtle

The seasonal distribution of leatherback sea turtles in the North Atlantic waters range from Cape Sable, Nova Scotia to Puerto Rico and the U.S. Virgin Islands. The waters of New England and Long Island Sound support the largest populations on the Atlantic coast during the summer and early fall (Lazell, 1980; Prescott, 1988; Shoop and Kenney, 1992). Leatherbacks have the potential to occur in Massachusetts waters from June through November in coastal and outer continental shelf waters (NOAA Fisheries, 2005a). During summer months, leatherbacks move into fairly shallow coastal waters following prey, while during the fall they move offshore and begin their migration south (Payne *et al.,* 1984). Incidental sea turtle observation data obtained by MA Audubon during 2002-2004 avian aerial and boat surveys identified 55 leatherbacks out of 115 total sea turtles observed, of which only 4 of the 55 turtles identified as leatherbacks were observed within the area of the proposed action.

4.1.2.3 Loggerhead Sea Turtle

Loggerhead sea turtles occur in the Northeast waters from May 1 through November 15, with higher abundances in the waters of f New York and the Mid-Atlantic States in the spring and summer (NOAA, 2005a). A small number of individuals that may reach the waters of New England consist mainly of juveniles (NOAA, 2005a). The presence of loggerhead sea turtles in New England waters has only been documented through incidental observations, strandings, entanglements and mariner reports, and the actual occurrence of loggerhead sea turtles in Nantucket Sound is expected to be rare (Ryder, 2002).

4.1.2.4 Green Sea Turtle

The range of the green turtle in the continental United States extends from Massachusetts to Texas. However, as the green turtle is typically a tropical and subtropical species, the occurrence of this species north of Virginia during any month of the year is considered unusual (NOAA, 2002; Thompson, 1988). Green turtles are typically considered stragglers when found in New England waters (USFWS, 2006). Therefore, in comparison to other species that may be seasonally observed in Nantucket Sound (i.e., Kemp's ridley, leatherback and loggerhead turtles), the green turtle is the least likely to be observed in Nantucket Sound.

4.1.3 Avian Species

4.1.3.1 Piping Plover

4.1.3.1.1 New England and Massachusetts

In Massachusetts, piping plover breed on beaches along the North Shore, South Shore, Upper Cape, Lower Cape, Bristol County, Elizabeth Islands, Martha's Vineyard, and Nantucket (Melvin and Mostello, 2007). Figure BA-9 (Plover) shows the breeding locations in the vicinity of Nantucket Sound. During the 2002 season, observers reported 106 active nest sites in Massachusetts (Melvin and Mostello, 2003). The Lower and Upper Cape Cod regions combined represented nearly 59 percent of Massachusetts' breeding pairs in 2002 and 2003 (Melvin and Mostello, 2003, 2007). In 2002, South Beach in Chatham and the Monomoy Islands supported over 14 percent of Massachusetts' total breeding pairs (Melvin and Mostello, 2003). These regions continue to support most of the Massachusetts population. Within Nantucket Sound and Vineyard Sound, piping plover nest on island beaches. The 2002 Massachusetts piping plover census reported 84 breeding pair of piping plover dispersed on the islands of Nantucket and Martha's Vineyard (Figure BA-9).

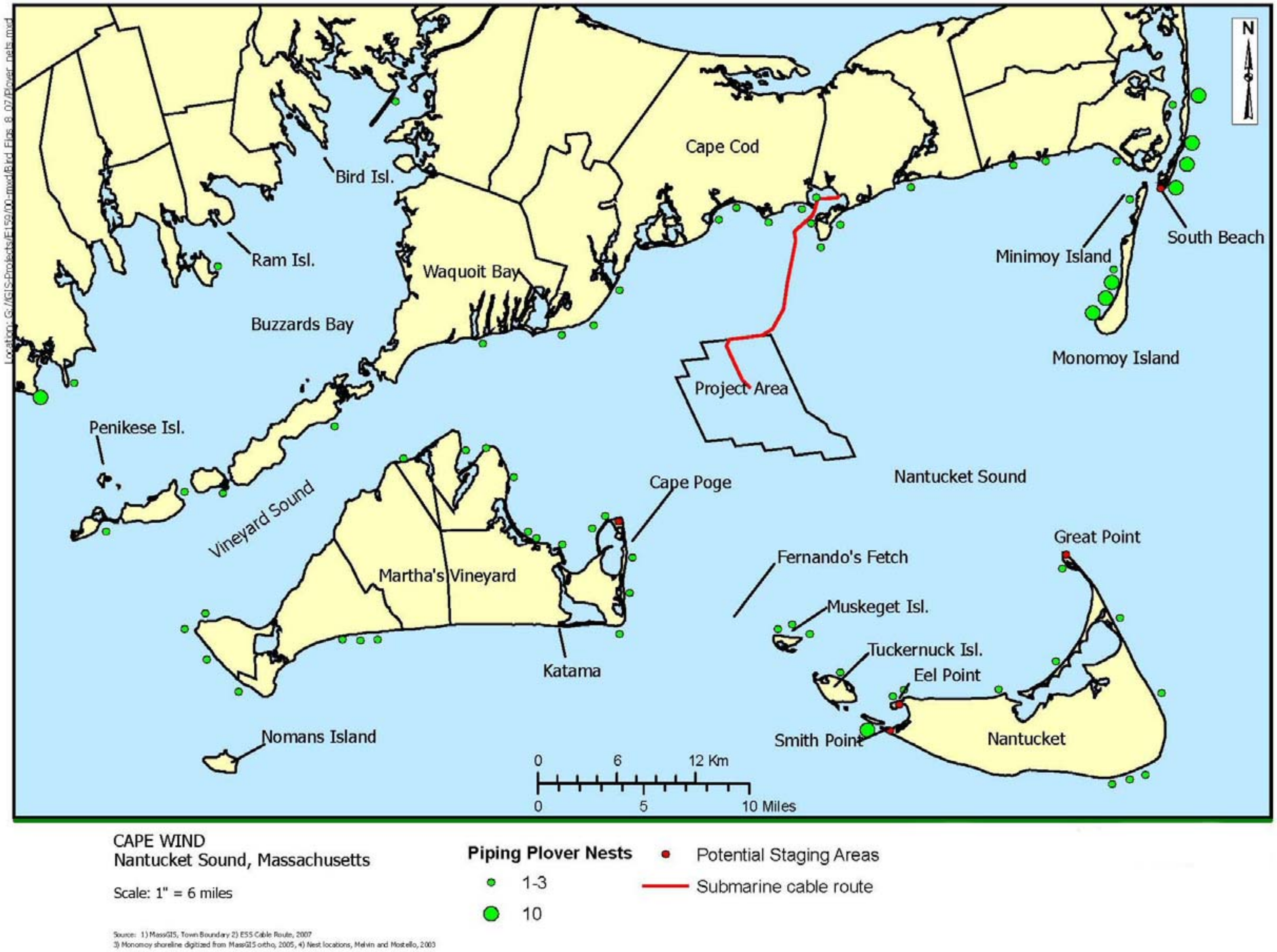


Figure BA-9.
Piping plover breeding locations in Nantucket Sound and Buzzards Bay in 2002

Estimates of the number of breeding pairs in Massachusetts are 475 and 472 for 2005 (preliminary) and 2006, respectively. The 2007 numbers of breeding pairs and productivity estimates are not yet available (Anne Hecht, pers. comm.). Massachusetts breeding pairs represent over 75 percent of the New England population (Figure BA-10).

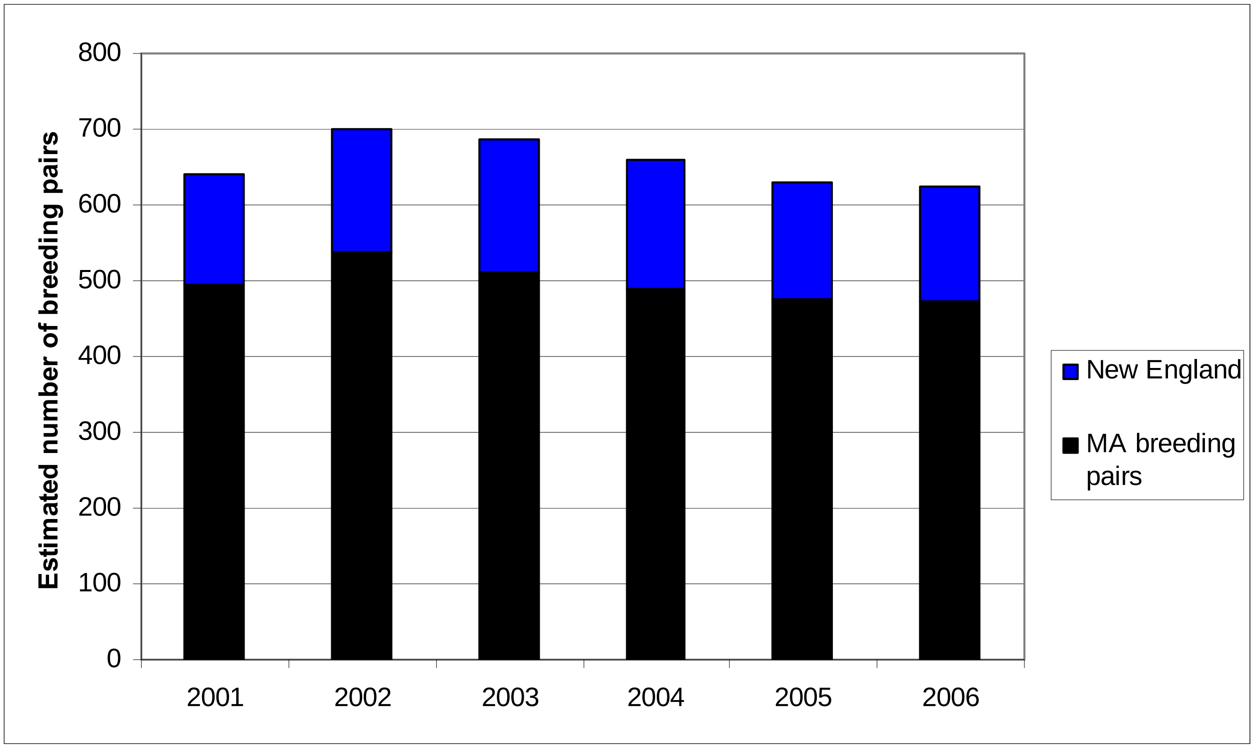


Figure BA-10.
Estimated number of piping plover breading pairs 2001-2006 – MA and New England (USFWS 2008)

In Massachusetts, the number of chicks fledged per pair in 2005 and 2006 was estimated to be 1.0 and 1.33 for 475 and 472 pairs, respectively (Figure BA-11). Figure BA-11 shows that, at least for the past six years, declines or increases in productivity are not correlated to the number of breeding pairs the following year.

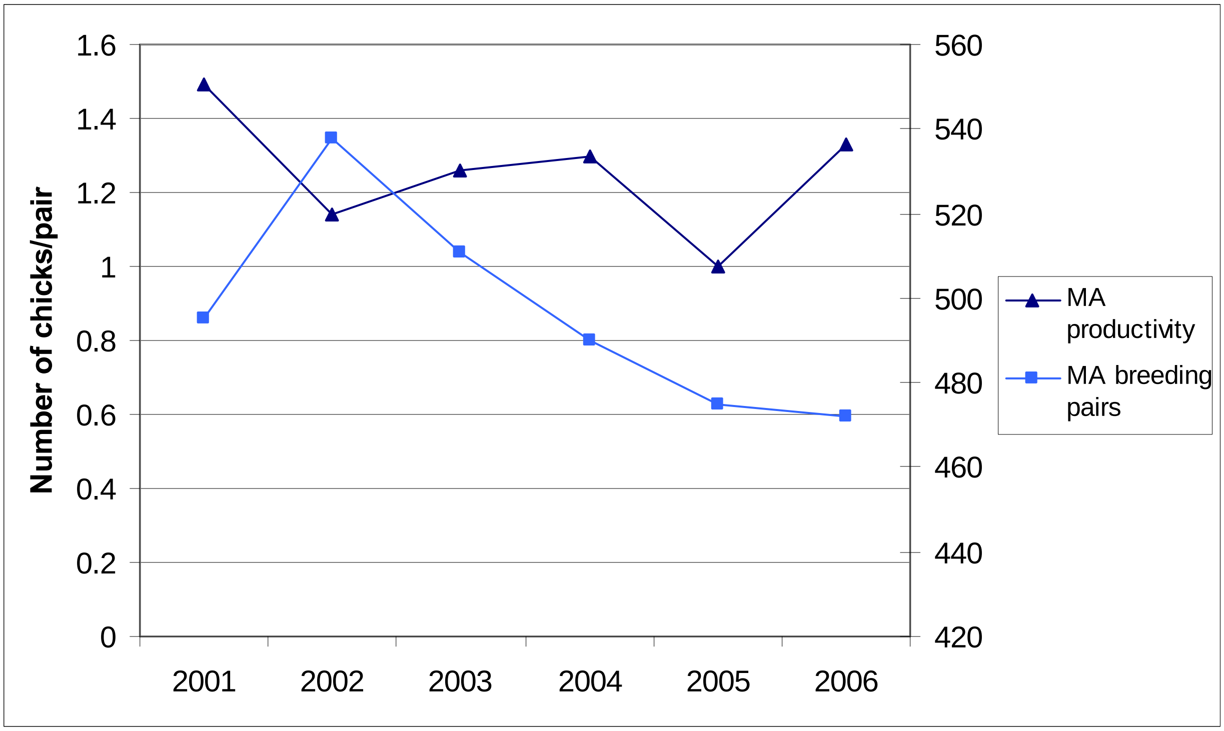


Figure BA-11.
Estimated productivity and number of piping plover breeding pairs 2001-2006 in MA (USFWS, 2008)

4.1.3.1.2 Piping Plover Use of the Project Area

Beginning in 2002, the Applicant and the Massachusetts Audubon Society (MAS) conducted studies to characterize bird use of Nantucket Sound. Between 2002 and 2004, and in 2006, the Applicant conducted 51 total aerial surveys and 48 boat surveys; and MAS conducted 81 total aerial surveys and 41 boat surveys. Between ESS and MAS, there were 132 aerial and 89 boat surveys conducted during the timeframe when piping plovers are present in the region.

The Applicant's and MAS's aerial surveys were conducted on days with light to moderate winds (<15 knots) and on days with good to excellent visibility (> 10 miles). Surveys were conducted during the day, at different times and during different tides. When conducting aerial surveys, the Applicant surveyed 16 transects over Nantucket Sound. Their transect width was 400 m with an overall survey length of 415 km, a 168 km^2 total survey area (Report No. 4.2.4-2). During MAS tern aerial surveys in Nantucket Sound, surveyors flew along 16 transects with a survey width of 400 km; the overall length of surveys was 401 km^2, with a 78 km^2 total survey area (Report No. 4.2.4-19).

During an aerial transect an observer mainly focused attention on a narrow strip of water while recording birds on the surface or flying close above it. ESS (see Appendix A to BA) noted that while focusing on that strip of water, observations were not limited precisely to the wedge-shaped volume of air between the surface of the water and the moving aircraft, particularly during the tern season when there were relatively few birds present (versus during the winter when seaducks are abundant). Therefore, observers were able to observe a wider volume, such as a rectangular cross-section.

During the Applicant's aerial surveys, the altitude of flying birds was estimated in relation to the surface of the water and the altitude of the plane (250 ft [75 m]), the approximate height of the proposed rotor hubs (257 ft [78.5 m]). Observed flight heights were categorized into 30 ft (10 m) height increments. Although the height measurements were not precise, the estimates were to serve the purpose of differentiating those birds flying within the proposed rotor zone from those birds that were above or below the rotor zone. The MAS aerial survey used a different type of plane which necessitated a higher flight path, one averaging 500 ft (150 m). Therefore, the MAS survey did not estimate flight heights below 300 ft (91 m) during aerial surveys.

During boat surveys, when birds were in the vicinity of observation vessels (300 ft [100 m]), flight height was estimated. Observers categorized flight heights into 20 ft (6 m) increments, using bird size, wave height, the vessel from which the observations were made, and other nearby vessels for scale. Flight height observations were made during MAS boat surveys. Flight heights were estimated from the observation boats by referencing objects of known heights such as the top of the wheelhouse, navigational buoys, and the Cape Wind test tower.

Limitations to the Available Survey Data

The boat and visual surveys and the radar ground-truthing surveys conducted in the study area by the Applicant and MAS provide a level of information regarding the presence of roseate tern and piping plover in the proposed action area and other areas of Nantucket Sound. This BA also includes a review of the available additional base of information from the scientific and commercial communities as well as any uncertainties or scientific debate surrounding the information available or limitations to such data. Part of this debate includes information from comments of Dr. Ian Nisbet (tern expert) and MDFW, as solicited by the FWS during the December 2007 review of a previous draft of this document and as received during the course of the environmental review of the proposed action (Nisbet, 2005; Nisbet, 2007; Nisbet personal communication; Appendices A and C). By including all of this information, MMS intends to provide the data and a range of potential, although not necessarily proven, limitations to this data in order to provide the FWS with a complete basis of best available information for its decision-making. The results of these data and the potential limitations to these surveys are outlined in this section and are taken into consideration throughout this document for the assessment of risk posed by the project.

MMS notes that Dr. Nisbet is a member of the FWS Roseate Tern Recovery Team and as such was asked by the FWS to review and comment on the December 2007 draft of this BA based on his expertise. MMS also notes that Dr. Nisbet is now also employed by a major opponent of this proposed action. We ask the FWS, as MMS will, to consider Dr. Nisbet's current affiliation with this project's opponent as the FWS analyzes Dr. Nisbet's review and comment on the proposed action.

Lack of Data during Periods of Reduced Visibility

The primary data gaps in the information available include: 1) a lack of plover occurrence and behavioral data collected in the proposed action area at night and during crepuscular periods, and 2) a lack of this data collected during inclement weather periods in HSS during the timeframe when piping plover may occur in the region. Regarding data gaps, Nisbet (2005) commented that surveys were 'restricted to daylight hours (0500-2000) and to good weather, and that data collected during bad weather, early mornings and late evenings would be essential; however, virtually no information was obtained about the occurrence or movements of [birds] in these circumstances.' These periods of reduced visibility may be the periods of greatest risk of collision and there is no data available describing piping plover occurrence or behaviors in HSS during these conditions.

Due to the limitations of the radar studies described below, radar data could not be used to provide information regarding the presence or the flight behaviors of piping plover that may occur over HSS at night.

Limitations to the Radar Surveys

Visual ground-truthing was conducted during the same timeframe as radar survey for 13 days in September 2002 and during 7 nights in May 2006 (Report No. 4.2.4-5, 4.2.4-6, 4.2.4.7). Nighttime radar data in the absence of infrared visual confirmation cannot provide species-specific information. Similarly, radar data obtained during the day with targets classified into flight speed and size-categories cannot be used to describe piping plover movement patterns or flight behaviors through HSS. The daytime ground-truthing conducted in September 2002 was not correlated with radar observations and was not used for the assessment of risk.

Radar technology is also limited in its ability to track targets flying close to the water's surface.

Therefore, very limited radar data collected during the day coupled with ground-truthing surveys was used in this assessment of risk to piping plover.

Limitations of Detection of Piping Plover during Visual Surveys

There is a potential that if piping plover did occur at locations over Nantucket Sound during aerial and boat visual surveys, they may have gone undetected. There were a number of unidentified shorebird species observations made during visual surveys over areas of Nantucket Sound (see *Results of Surveys and Available Information* below). Data collected during aerial surveys at an altitude of 250 ft (75 m) or greater should be interpreted with caution due to the difficulties detecting small, light-colored birds at the water's surface from the height of the aircraft. Also, during aerial surveys, there was no observer dedicated to looking for high-flying birds above the height of the plane, so if present, these birds would have gone undetected. Nisbet (2005) noted:

> "The aerial surveys were conducted by looking downward between calibrated markers from an aircraft flying at 75 m altitude. In these circumstances, no birds flying higher than 75 m would have been observed, and birds flying between 23 and 75 m would have been difficult to detect a) because the observers' attention was directed at the sea surface, b) because the width of the transect declined linearly with distance below the aircraft, and c) because they would be seen more fleetingly than birds further below."

Nisbet (2007) noted that some high flying [birds] may have been undetected due to the 'wedge-shaped' area of visibility from an aircraft (Nisbet, 2007). Nisbet (2007) suggests that the volume of space visible from an aircraft is widest at the surface, and 'tapers to a line along the path of the aircraft'.

There are limits to an observer's ability to detect high flying birds during boat surveys or on the ground. Nisbet (2005; 2007) notes that except for large, dark birds, it is difficult to see high flying [birds] against a bright sky or clouds at heights greater than 60-90 m, especially from a moving boat. MDFW has also noted that data collected from a rocky boat should not be considered reliable (MDFW, personal communication). And the ability to detect [birds] at very high altitudes in low light conditions would be lower than an observer's ability to detect [birds] flying in daylight at lower altitudes. MDFW indicated that 100 m may be at the maximum of the normal range of the detectability of observers at ground level.

As they are small, light colored birds, piping plovers can be difficult to detect even during the day and in good weather conditions. They would be easy to miss if flying near the surface of the waves during aerial surveys, and easy to miss if flying high against a bright sky during surveys conducted at the water's surface.

There is very little data regarding the potential for piping plover crossings of Nantucket Sound during the breeding and migration seasons. Due to the difficulties in detecting piping plover during visual surveys, the inability to conduct visual surveys at night, and the inability to identify species with radar at night (without infrared visual confirmation) telemetry surveys would be beneficial in determining piping plover occurrence and/or movement patterns in Nantucket Sound during a variety of conditions during the migration and breeding seasons. However, current telemetry technology does not allow for the collection of flight height data.

Results of Surveys and Available Information

During the daytime studies conducted from 2002 to 2004, and in 2006, no piping plovers were observed in the area of the proposed action (HSS) or in the other areas of Nantucket Sound included in the studies. There is no information regarding the potential of piping plover occurrences in the area of the proposed action at night or during periods of inclement weather.

Few observations of shorebirds took place during the Applicant's and MAS's visual surveys overall. Twenty dunlin (*Calidris alpina*) were observed in the study area during a fall aerial survey in 2002 (Report No. 4.2.4-9). A total of 6 unidentified sandpiper species and 1 red knot (*Calidris canutus*) were observed off Cape Poge in September 2002 (Report No. 4.2.4-3). A total of 50 unidentified shorebirds were seen during the summer 2003 surveys outside of the shoal study areas and in the vicinity of Nantucket Sound (Report No. 4.2.4-5); and 183 unidentified shorebird species were seen over the Nantucket Sound study areas during MAS's surveys in the fall seasons of 2002 to 2004 (birds observed outside of study areas and birds observed resting along beaches or shallows were removed from this dataset) (Sadoti *et al*., 2005b).

Some species including dunlin and red knot are notably darker, larger shorebird species than piping plover and would therefore be easier to detect. Relatively few observations of shorebirds compared to other waterbirds could indicate minimal use of the Sound by shorebird species, or it could reflect the difficulties in adequately surveying for this group of birds during aerial or boat surveys.

Breeding Period

Once nesting locations are established, piping plovers are relatively sedentary. Most of their movements involve walking or running as opposed to flying because of their cryptic coloration on the ground (Haig and Elliot-Smith, 2004). Because nesting and feeding habitats are proximal, movements between the locations are relatively short. Once the chicks have hatched, the area between nesting locations and foraging areas increases (USFWS, 1996). Once the chicks have reached fledgling status, family groups become more mobile. Telemetry data gathered in North Dakota suggests that juveniles may travel more than 32 miles (50 km) within a few days of being able to fly (Haig and Elliot-Smith, 2004).

It is important to note that failed breeders and unpaired birds could be more mobile during the breeding season. Crossings of the area of the proposed action are a potential during the breeding season, but no data have been recorded. Therefore, potential flight paths are not known. There is the potential that individuals could travel between the mainland to Nantucket or Martha's Vineyard in search of a mate or habitat during the breeding season. However, a study conducted on outer Cape Cod indicated that most breeding plovers did not change mates or move to new territories between nesting attempts (MacIvor, 1990). Aerial and boat surveys conducted in HSS found no movement of piping plovers in the area of the proposed action during the day see Limitations to the Available Data). More data collected in a variety of weather conditions and at night is required to more fully assess these potential movements.

Migration

In addition to the breeding season, birds could occur in the area of the proposed action during migration. Migrant birds from interior U.S. and Canada, as well as Atlantic Canada and New England, have been documented along the Atlantic Coast during migration (Haig and Elliot-Smith, 2004). Little is known of the actual migration routes of Atlantic Coast piping plover during migration. However, observations of staging birds along the Atlantic Coast suggest that piping plover make short-distance movements to stop-over sites and may follow a narrow corridor along the coastline (Haig and Elliot-Smith, 2004; USFWS, 1996). There are very few sightings of Atlantic Coast plovers offshore or inland during migration (USFWS, 1996). Plovers have been observed at wintering grounds on islands in the Caribbean (USGS, 2007; Haig and

Elliot-Smith, 2004); therefore, they will undertake long-distance ocean crossings. There are documented reports of pre-migratory staging plovers on the Cape Poge Elbow, the eastern point of Martha's Vineyard (USFWS, 1996). There is potential migrant use of Smith Point and Great Point, Nantucket (USFWS, 1996). South Beach, Chatham is considered a stop-over site for migratory piping plover, and if they were to depart the island for a destination in Long Island, New York, they could cross areas of Nantucket Sound. Pre-breeding plovers have been observed staging on Eel Point, Nantucket Sound (USFWS, 1996).

Piping plover could potentially cross areas of the Vineyard Sound or Nantucket Sound in order to access or depart breeding or staging locations on Martha's Vineyard and Nantucket. Additionally, weather events could potentially push migrants following the coastline either inland or offshore. It is unknown, however, if these movements would result in crossings of HSS. Further study is required to assess these potential movements in a variety of weather conditions and at night. Telemetry surveys would be beneficial in determining piping plover movement patterns in Nantucket Sound during a variety of conditions (refer to Section 8 for description of post-construction monitoring plan). However, there is not yet a reliable method to tag and track piping plover that would produce flight height data over HSS.

4.1.3.2 Roseate Tern

4.1.3.2.1 Breeding Season

The majority of roseate terns in the Northeast and Canada breed between Long Island and Cape Cod, with the largest colonies located on Great Gull Island, New York, and on Bird and Ram Islands in Buzzards Bay. In Massachusetts, roseate terns are present from late April until mid-September, during the breeding and pre-migratory staging periods. Northeast birds arrive from late-April to mid-May and some are thought to aggregate in Nantucket Sound before dispersing to breeding locations near Long Island, in Buzzards Bay, Maine, and Canada. An estimated 10 to 12 percent of the roseate population travels north of Nantucket Sound, while 88 to 90 percent moves south and west in Buzzards Bay and Long Island Sound (RTRT, 2007).

Figure BA-12 shows the roseate tern active breeding, potential breeding, staging, and resting locations in Cape Cod, Nantucket Sound, Vineyard Sound, and Buzzards Bay in Massachusetts. In 2005, there were 27 breeding pairs of roseate terns on South Monomoy Island, one pair on Minimoy Island, and 26 pairs located off of the Monomoy Refuge (USFWS, 2005), located approximately 12 mile (19.3 km) from the area of proposed action in Horseshoe Shoals (HSS). There were 27 pairs on Minimoy and 2 pairs on South Monomoy in 2006. In 2007, fifty-six total breeding pairs were recorded at Minimoy and 2 pairs nested on South Monomoy (RTRT, 2007). Since 1999, there have been small numbers of pairs believed to be nesting on Smith Point, Nantucket (12.9 mile [20.8 km] from the nearest edge of the proposed action in HSS) and Muskeget Island (8.6 mile [13.8 km] from the nearest edge of the project) in Nantucket Sound. However, in recent years, neither nests nor chicks have been confirmed at these locations (RTRT, 2007).

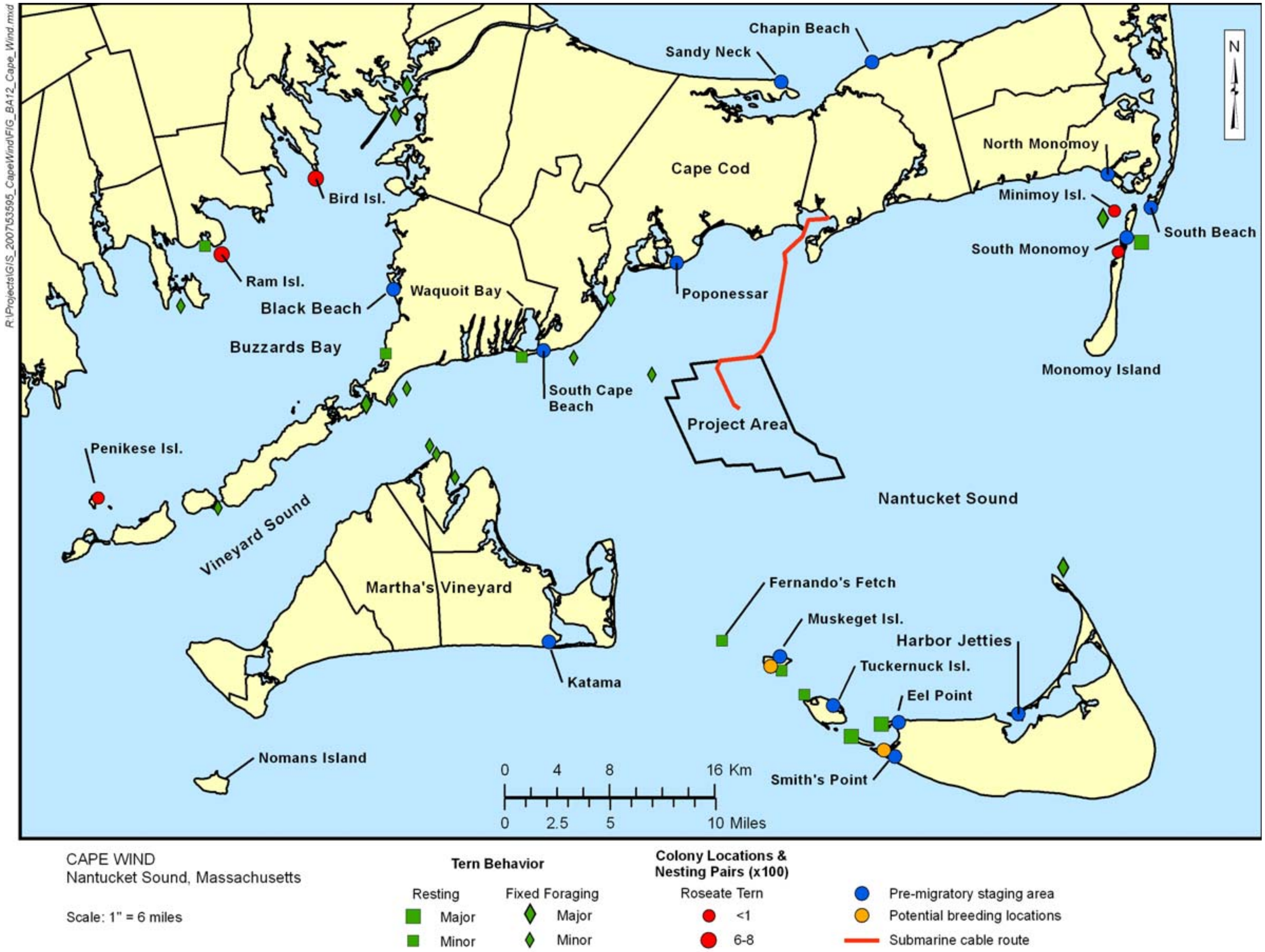


Figure BA-12.
Roseate terns in Nantucket Sound and Buzzards Bay (Report No. 5.3.2-1; Trull *et al.,* 1999; RTRT, 2007; MDFW-NHESP, personal communication)

In Buzzards Bay, Bird and Ram Island are designated Audubon Important Bird Areas because of the islands' significant tern breeding habitat. In the late 1900s, Bird Island supported the largest population of breeding pairs in North America. However, Ram Island became the more substantial colony in the 1990s due to erosion on Bird Island and gull control on Ram Island. Within recent years, Bird Island has re-emerged as the more substantial colony of the two islands. Owl predation on Ram Island in 2005 was presumed to be attributed to an increase of nesting pairs on Bird Island in 2006 (Causey and Mostello, 2006). Between the two islands, in the past 7 years there have been 1,543 to 2,409 breeding pairs of roseate terns (RTRT, 2007), as well as thousands of breeding common terns. The closest edge of proposed action in HSS is located approximately 19.3 mile (31.1 km) from Bird Island and 22.07 mile (35.5 km) from Ram Island. In the 1890s, Penikese Island in Buzzards Bay was one of less than ten roseate and common tern colonies (consisting of substantial numbers) on the Atlantic Coast to survive the plume trade. Penikese Island is located 27.1 mile (43.7 km) from the nearest edge of the proposed action in HSS. The island supported up to 10,000 pairs as recently as 1952; however, this colony was overtaken by gulls in the 1950s. Tern habitat restoration was initiated on the island in 1998. In 2003, after the Bouchard oil spill, roseate and common terns were discouraged from nesting on Ram Island until the oil was removed. As a result, 250 pairs of roseate terns nested on Penikese Island. Currently Penikese Island supports about 900 pairs of common terns and over 100 pairs of roseate terns (MDFW, unpublished data; RTRT, 2007).

Although there have been no confirmed nests in the past 7 years, additional Massachusetts locations where a few pairs of roseate terns have been reported include: Plymouth Beach and Gray's Beach in Yarmouth, Nauset-New Island in Eastham, and Dead Neck-Sampons Island (RTRT, 2007). Sandy Neck, Nauset-Chatham, North Monomoy Island, Haystack Point and Menemsha Pond in Martha's Vineyard, and Nashawena Island in Buzzards Bay have had no known pairs since 1998, or earlier (RTRT, 2007).

Figure BA-12 shows known roseate tern foraging locations in Buzzards Bay, Vineyard Sound, and Nantucket Sound. Roseate tern foraging locations vary daily and seasonally and are dependent on the tide and prey location and availability (Heinemann, 1992; ESS 2007; Report 5.3.2-1). Roseate terns are known to forage as far as 16 to 19 miles (25 to 30 km) from colony sites (Heinemann, 1992). A study conducted at Falkner Island, Connecticut confirmed these distances (Lebreton *et al.*, 2003). Locations that have been found to be important roseate tern foraging sites among different years include Woods Hole, Falmouth (10 mile [16 km] from Bird Island), near the entrance to the western end of the Cape Cod Canal (3 to 7 mile [5 to 11 km] from Bird Island); and the Mashnee Flats Shoal near the Cape Cod Canal (5.3 mile [9 kilometers (km)] from Bird Island) (Heinemann, 1992). Roseate terns nesting at Bird Island were regularly observed traveling (12 to 19 mile [20 to 30 km] from Bird Island) to forage in Vineyard Sound. Also, flocks of terns were regularly observed foraging along the shore of Cape Cod from Woods Hole to Poponesset Bay (Heinemann, 1992).

Although the area of proposed action in Horseshoe Shoals (HSS) does not occur within nesting habitat or the most heavily used foraging habitats during the breeding season, daily foraging and traveling activity during the early spring arrival, breeding, pre-migratory, and fall-staging periods does occur in the area of proposed action.

In order to determine tern use of the area of proposed action, boat and aerial visual surveys were conducted. From 2002 to 2004 and in 2006, MAS and the Applicant conducted aerial surveys (mid-May through mid-September) over the area of proposed action in HSS and surrounding areas in Nantucket Sound.

The Applicant's and MAS's aerial surveys were conducted on days with light to moderate winds (<15 knots) and on days with good to excellent visibility (>10 miles). Surveys were conducted during the day, at different times and during different tides. When conducting aerial surveys, the Applicant surveyed 16 transects over Nantucket Sound. Their transect width was 400 m with an overall survey length of 415 km, a 168 km^2 total survey area (Report No. 4.2.4-2). During MAS tern aerial surveys in Nantucket Sound, surveyors flew along 16 transects with a survey width of 400 km; the overall length of surveys was 401 km^2, with a 78 km^2 total survey area (Report No. 4.2.4-2).

During an aerial transect an observer mainly focused attention on a narrow strip of water while recording birds on the surface or flying close above it. ESS (see Appendix A to BA) noted that while focusing on that strip of water, observations were not limited precisely to the wedge-shaped volume of air between the surface of the water and the moving aircraft, particularly during the tern season when there were relatively few birds present (verses during the winter when seaducks are abundant). Therefore, observers were able to observe a wider volume, such as a rectangular cross-section.

During the Applicant's aerial surveys, the altitude of flying birds was estimated in relation to the surface of the water and the altitude of the plane (250 ft [75 m]), the approximate height of the proposed rotor hubs (257 ft [78.5 m]). Observed flight heights were categorized into 30 ft (10 m) height increments. Although the height measurements were not precise, the estimates were to serve the purpose of differentiating those birds flying within the proposed rotor zone from those birds that were above or below the rotor zone. The MAS tern aerial survey in Nantucket Sound used a different type of plane which necessitated a higher flight path, one averaging 500 ft (150 m). Therefore, the MAS survey did not estimate flight heights below 300 ft (91 m) during aerial surveys.

During boat surveys, when birds were in the vicinity of observation vessels (300 ft [100 m]) flight height was estimated. Observers categorized flight heights into 20 ft (6 m) increments, using bird size, wave height, the vessel from which the observations were made, and other nearby vessels for scale. Flight height observations were made during MAS boat surveys. Flight heights were estimated from the observation boats by referencing objects of known heights such as the top of the wheelhouse, navigational buoys, and the Cape Wind test tower.

Due to the limitations of the radar studies described below, radar data could not be used to provide information regarding the presence or the flight behaviors of roseate terns that may occur over HSS at night.

Limitations to the Available Survey Data

The boat and visual surveys and the radar ground-truthing surveys conducted in the study area by the Applicant and MAS provide a level of information regarding the presence of roseate tern and piping plover in the proposed action area and other areas of Nantucket Sound. This BA also includes a review of the available additional base of information from the scientific and commercial communities as well as any uncertainties or scientific debate surrounding the information available or limitations to such data. Part of this debate includes information from comments of Dr. Ian Nisbet (tern expert) and MDFW, as solicited by the FWS during the December 2007 review of a previous draft of this document and as received during the course of the environmental review of the proposed action (Nisbet, 2005; Nisbet, 2007; Nisbet personal communication; Appendices A and C). By including all of this information, MMS intends to provide the data and a range of potential, although not necessarily proven, limitations to this data in order to provide the FWS with a complete basis of best available information for its decision-making. The results of these data and the potential limitations to these surveys are outlined in this section and are taken into consideration throughout this document for the assessment of risk posed by the project.

MMS notes that Dr. Nisbet is a member of the FWS Roseate Tern Recovery Team and as such was asked by the FWS to review and comment on the December 2007 draft of this BA based on his expertise. MMS also notes that Dr. Nisbet is now also employed by a major opponent of this proposed action. We ask the FWS, as MMS will, to consider Dr. Nisbet's current affiliation with this project's opponent as the FWS analyzes Dr. Nisbet's review and comment on the proposed action.

Lack of Data during periods of Reduced Visibility

Primary data gaps in the information available for the assessment of risk include: 1) a lack of tern occurrence and behavioral data collected in the proposed action area at night and during crepuscular periods, and 2) a lack of this data collected during inclement weather periods in HSS during the timeframe when roseate terns are present in the region. These periods of reduced visibility may be the period of greatest risk of collision and there is very limited data describing roseate tern occurrence or behaviors in HSS during these conditions. Direct observational information about nocturnal movements of terns is limited; much depends on inferences drawn from movements observed near dawn and dusk. The timing of evening arrivals at, and morning departures from, nocturnal roosts (and nesting colonies) are addressed in the discussion of collision risk.

Nisbet (2005) commented that surveys were 'restricted to daylight hours (0500-2000) and to good weather, and that data collected during bad weather, early mornings and late evenings would be essential[;however], virtually no information was obtained about the occurrence or movements of waterbirds in these circumstances.' To-date, there have been very limited observations made of terns after dark in the study area during surveys conducted by both the Applicant. Visual surveys resulted in one observation which occurred on August 15, 2002 of terns flying through the southern part of the study area toward a transient sand bar, Ferdando's Fetch, after dark. Nisbet (2005) indicated that more systematic surveys conducted during this time in the evening at roosting locations and in HSS would be necessary for the assessment of risk. The Applicant made observations on 4 evenings in August 2006 of terns departing from an on-shore staging area where terns have been known to roost overnight (South Beach). The surveys were limited to 17.9 hours of observation during a single post-breeding staging period. The observation site is located greater than 15 miles from the perimeter of the proposed action; therefore, as MDFW indicated (in their 3/22/07 comment letter for the FEIR), the relevance of these results to HSS should be interpreted with caution. Additionally, it should be noted that the observed terns may not have reached their maximum flight altitude when passing over the observation location, suggesting that potentially more than the observed number of terns at rotor height may have flown at rotor-height over Nantucket Sound, and potentially HSS. MDFW indicated that more surveys conducted from roosting and staging sites are needed to assess the commuting heights of terns over HSS because it is expected that traveling terns may more frequently (than foraging terns) occur within the rotor swept zone (MDFW, personal communication). Terns may leave the colony-site at night in response to predators such as Great Horned Owls. At Bird Island, when conditions have allowed (on unusually calm nights), tern biologists have heard flocks of such displaced terns as they flew over the nearby waters in darkness through the night. It seems reasonable to infer that such flocks remain near the colony, but information confirming the absence of long-distance movements could be useful (ESS Group, personal communication).

Nisbet (personal communication) indicated that flight height and flight behavior data combined between the 4 nights of data collected during the August 2006 surveys and the 7 nights of data collected during ground-truthing radar surveys in May 2006 is too small a sample size to represent tern behaviors during the evening, and the data was biased by the fact that these boat surveys may have missed high-flying terns. From a boat it would have been difficult to collect accurate flight height data with a laser range finder; therefore, the statistical validity of estimates of the mean proportion of roseate terns that flew at rotor height across the study area is compromised (Nisbet, personal communication). Also, Nisbet indicated that winds during the four nights surveyed in August 2006 were predominantly from the Northeast and he expects that terns would have likely been flying lower during these conditions; additional surveys conducted during wind conditions that are representative of the prevailing southwest winds would be useful for the assessment of risk. Nisbet (personal communication) indicated that these limited survey hours are not adequate in describing the averages or representative numbers, densities, times of day, or heights of flight of terns commuting towards the South Beach roost.

Due to the limitations of the radar studies described below, the majority of radar data collected in the study area could not be used to provide information regarding the flight behaviors specific to roseate tern in HSS at night or during the day.

Limitations to the Radar Surveys

Radar data is limited its ability to track targets flying close to the water's surface and there are also inadequacies in categorizing targets as terns based on the speed of targets due to the differences in speeds of foraging verses commuting terns (Nisbet, 2005). Nighttime radar data in the absence of infrared visual confirmation cannot provide species-specific information. Similarly, radar data obtained during the day with targets classified into flight speed and size-categories cannot be used to describe roseate tern movement patterns or flight behaviors through HSS in the absence of visual confirmation. Visual ground-truthing was conducted during the same timeframe as radar surveys for 13 days in September 2002, and during 7 nights in May 2006 (Report No. 4.2.4-5, 4.2.4-6, 4.2.4.7). The daytime ground-truthing conducted in September 2002 was not correlated with radar observations and was not used for the assessment of risk. Therefore, very limited radar data collected during the day coupled with ground-truthing surveys was used in this assessment of risk to roseate terns (see *Results of Surveys and Available Information)*.

Limitations in Estimations of Flight Heights

There are difficulties accurately describing flight heights during boat and aerial surveys. The flight height of terns is an essential factor when considering risk of collision with the proposed action structures. Obtaining flight altitudes over the ocean is difficult due to the lack of objects that provide scale. During the Applicant's aerial surveys, the altitude of flying birds was estimated in relation to the surface of the water and the altitude of the plane (250 ft [75 m]). Observed flight heights were categorized into 30 ft (10 m) height increments. Although the height measurements were not precise, the estimates were to serve the purpose of differentiating those birds flying within the proposed rotor zone from those birds that were above or below the rotor zone. Although the Applicant's aircraft surveys did not include an observer dedicated to looking for high-flying terns, the pilot reported, over the plane's intercom, numerous sightings of birds beyond the transects and at high altitudes; these did not suggest that significant numbers of high-flying terns were present.

During the Applicant's boat surveys, when birds were in the vicinity of observation vessels (300 ft [100 m]), flight height was estimated. Observers categorized flight heights into 20 ft (6 m) increments, using bird size, wave height, the vessel from which the observations were made, and other nearby vessels for scale. MAS generally did not estimate flight heights below 300 ft (91 m) during aerial surveys conducted at an average height of 500 ft (150 m); however, MAS made flight height observations during boat surveys. Flight heights were estimated from the observation boats by referencing objects of known heights such as the top of the wheelhouse, navigational buoys, and the Cape Wind test tower.

Flight heights documented during aerial surveys conducted at 250 ft (75 m) or greater should be interpreted with caution due to the difficulties detecting small, light-colored birds at the water's surface from the height of the aircraft. Also, during aerial surveys, there was no observer dedicated to looking for high-flying terns above the height of the plane, so if present, these birds would have gone undetected. Nisbet (2005) noted:

> "The aerial surveys were conducted by looking downward between calibrated markers from an aircraft flying at 75 m altitude. In these circumstances, no birds flying higher than 75 m would have been observed, and birds flying between 23 and 75 m would have been difficult to detect a) because the observers' attention was directed at the sea surface, b) because the width of the transect declined linearly with distance below the aircraft, and c) because they would be seen more fleetingly than birds further below."

Nisbet (2007) noted that some high flying terns may have been undetected due to the 'wedge-shaped' area of visibility from an aircraft (Nisbet, 2007). Nisbet (2007) suggests that the volume of space visible from an aircraft is widest at the surface, and 'tapers to a line along the path of the aircraft'.

There are limits to an observers' ability to detect high flying targets during boat surveys or on the ground. Nisbet (2005; 2007) notes, that except for large, dark birds, it is difficult to see high flying birds against a bright sky or clouds at heights greater than 60-90 m, especially from a moving boat. In their comment letter (dated 3/22/07) to the FEIR, MDFW also noted that flight altitudes estimated from a rocky boat should be under question. And the ability to detect terns at very high altitudes in low light conditions would be lower than an observer's ability to detect terns flying in daylight at lower altitudes. Courtship flights, which occur at high altitudes, in particular would be easy to miss on the ground, even during periods of good visibility. MDFW indicated that 100 m may be at the maximum extent of the normal range of the detectability of observers at ground level; therefore, the percent of terns observed in the rotor zone during visual surveys should be considered a minimum and not a maximum value.

Unknown numbers of high flying terns may have gone undetected during both aerial and boat surveys. Therefore, the overall percent of terns flying within the rotor zone may have been underestimated. Nisbet (2005) indicates that because of the inability to detect some low-flying and high-flying birds during visual surveys, it is insufficient to use the proportion of terns in the rotor-zone observed during visual surveys to assess risk of collision.

Given that some high-flying and low-flying terns may not have been detected during visual surveys, the density of terns observed in HSS may have been underestimated. However, this bias in observation would have been consistent during visual surveys in HSS and other areas of Nantucket Sound so that, although the total number of terns present was likely underestimated, the proportion of terns in HSS in relation to other areas of the Sound is likely accurate.

Data Gaps about Tern Movement Patterns through HSS

Nisbet (2005) noted gaps in the data available about waterbird movements through the project area, particularly related to patterns of movement through HSS while commuting between colony locations and foraging habitats. An additional boat survey was conducted from August 28 to August 31, 2006, to observe the movement of terns near the staging area on South Beach and Monomoy Island (Report No. BA-1). Nisbet (2007) identified a need to better assess birds' flight directions and movements during prevailing southwest wind conditions, which would provide information for the assessment of risk throughout the timeframe when the terns are present, and in a variety of visibility conditions.

Generalizations about Common and Roseate Terns

Another source of uncertainty surrounding the available data stems from the inability to consistently identify terns to the species level during both the Applicant's and MAS's surveys. The majority of terns observed were counted generally as 'terns' including both common and roseate terns. This results in uncertainty surrounding the number of roseate terns and the density of roseate terns that occur in the study areas within Nantucket Sound. Pooled tern data results in generalizations about tern behavior when there are known differences between common and roseate tern flight behaviors. This issue, as outlined in *Collision Risk Modeling* is also a concern when estimating the percent of roseate terns among general tern observations to estimate the probability of collision.

Limited Number of Survey Hours during Critical Seasons

Roseate terns are known to be present in the region from late-April through September. The Applicant's and MAS' visual and radar surveys targeted the breeding, post-breeding, and migration periods of terns during 2002, 2003, 2004, and also the tern migration and breeding period during the spring and summer of 2006.

Nisbet (2005) indicated that the survey coverage (11 aerial and 5 boat surveys in 2002 and 2003) during migration periods (April, October-November) survey coverage was inadequate to fully address risk during these timeframes:

> "For [common terns], larger numbers were recorded during these periods in one or both of the years studied than the summer… periods. Because most of these birds were in transit through the area [during these survey periods], considerable fluctuations in numbers are expected from day to day and even from hour to hour."

Nisbet (2005) indicated prior to Mass Audubon's surveys in 2004, that the breeding season (May-September) boat and aerial surveys (Applicant: 17 aerial and 10 boat; MAS: 9 aerial and 3 boat) during 2002 and 2003 were inadequate. Nisbet (2005) considered the coverage during this season among the two years as minimally adequate due to the substantial seasonal differences in tern distribution.

Nisbet (2007) indicates that Mass Audubon's third year of studies (conducted in 2004) was not sufficient, and he recommended at least one more year's data to reduce uncertainty of risk. Nisbet (personal communication) indicated that flight height and flight behavior data combined between the 4 evenings surveyed in August 2006 and the 7 nights of data collected during ground-truthing radar surveys in May 2006 is too small a sample size for statistical validity of results.

Collection of another year of daytime boat and aerial surveys would not address the existing data gaps; although additional studies including telemetry, aerial surveys and infrared imaging could provide information, current technology and survey methods are limited or impractical.

For example, a roseate tern telemetry study would be needed to assess tern movements throughout the time period that they are present in the region through HSS during the day, at night, during crepuscular periods, and during inclement weather. However, current telemetry technology can not provide flight height information. In order to more accurately estimate flight heights during visual surveys, surveys from jack-up barges that offer a more stationary surface would be necessary and observers dedicated to the sighting of high-flying terns would also be necessary. Infrared imaging conducted at and near roosting sites such as Fernando's Fetch and South Beach and in HSS at night could also provide valuable behavioral data. Certainly, a more definitive way to evaluate risk posed to roseate terns would to be to conduct post-construction monitoring (as described in Section 8).

Results of Surveys and Available Information

The data that is available and will be used to the extent possible in the assessment of risk to roseate terns includes: 1) the total numbers and densities of terns observed during daytime (and a limited number of evening) visual surveys, 2) the flight height estimates made during visual and radar surveys and the proportion of detected terns within, above, and below the rotor zone, 3) the proportion or density of all terns observed in HSS in relation to other studied areas in Nantucket Sound, and 4) data describing tern flight heights when flying into following winds or while traveling upwind, and correlations between tern flight heights and wind speed.

Breeding Season Aerial Surveys

During the breeding season (mid-May to late July), MAS and the Applicant conducted a total of 15 aerial surveys (76 total survey hours) from 2002 to 2004 to document tern activity in the HSS and the shoals alternative study areas (Monomoy-Hankerchief Shoals and Tuckernuck Shoals) and in other parts of Nantucket Sound. Boat surveys were conducted during this timeframe over the survey years for a total of 89 survey hours during 47 total boat surveys.

Locations of Observations

MAS breeding season surveys documented sightings of 21 roseate terns, 828 common terns, and 1,605 common-roseate-type terns throughout Nantucket Sound (Perkins *et al.,* 2004a; Sadoti *et al.,* 2005a). Of the total number of terns observed in 2003 during the MAS surveys, 1.5 percent occurred in HSS, 5.3 percent in Monomoy-Hankerchief Shoals (MHS), 2.5 percent in Tuckernuck Shoals (TS), and 90.7 percent were outside of shoal study areas (Perkins *et al.,* 2004a; Sadoti *et al.,* 2005a). In 2004, of all the terns observed, 0 percent occurred in HSS, 0.7 percent in MHS, 0 percent in TS, 99.3 percent were outside of the shoal study areas. During surveys, the majority of terns were observed over shallow waters close to the shorelines of Cape Cod, Martha's Vineyard, and Nantucket (Figure BA-12). Of the 2,888 total terns observed during the Applicant's breeding season surveys, 9.6 percent occurred in HSS, 2.6 percent in MHS, 5.7 percent in TS, and 82.1 percent were outside of the shoal study areas (USACE 2004. Report No. 4.2.4-3, 4.2.4-8, and 4.2.4-10).

Of the 680 terns observed during MAS' aerial surveys in 2003, 66.3 percent were observed near Monomoy while 7 total terns (1.0 percent) were observed over HSS (Perkins *et al.,* 2004a). Of the 641 total terns observed during MAS' 2004 aerial surveys, 82 percent were observed near Monomoy and 0 percent were observed over HSS (Sadoti *et al.,* 2005a). Excluding terns observed along survey transects near Monomoy, 6.5 percent of terns were observed over MHS and 4.6 percent were observed over TS. During the Applicant's 2002 and 2003 breeding season aerial surveys, a total of 230 roseate terns and 900 mixed-terns were observed in the three shoals study areas while 471 roseate terns and 7,876 mixed-terns were observed in areas outside of the shoals. In 2002, there were 1,767 terns observed in the shoals study areas and 3,077 terns observed outside of the shoal study areas. In 2003, 223 terns were observed in the three study areas, while 11,886 were observed outside of the shoals areas; most terns were observed along the southern shore of Cape Code near Monomoy as well as near Tuckernuck Island (Report No. 4.2.4-3, 4.2.4-8, and 4.2.4-10).

Based on the combined data for all tern observations during the breeding season (May 12-July 30) during the Applicant's and MAS aerial surveys, the average density of terns observed in 2.6 km^2 (1 mi^2) grid cells within the total surveyed areas were calculated (based on the count of individuals along transects within each grid cell and the number of survey dates within each grid cell). The average density of terns observed within all grid cells within HSS during the breeding season ranged from 0 to 6-10 terns per square km except for one grid cell located at the southeast boundary of the proposed action area where an average density of 26 to 50 terns per square km were observed (Report No. 4.2.4-2). The range in the average density of 0 to 6-10 terns per square km was comparable throughout surveyed areas in Nantucket Sound except for Muskeget Island and 3 km (2 miles) northwest of the island at Ferdando's Fetch where the average density of terns ranged from 11-25 to 26-50 terns per square km, respectively; the Monomoy Islands where the average density of terns ranged from 6-10 to 101-160 terns per square km (Report No. 4.2.4-2).

The highest density of terns during the breeding season were documented near the Monomoy Islands (Report No. 4.2.4-2). In 2002, several of the Applicant's boat surveys documented large aggregations of resting terns at Fernando's Fetch, a transient sandbar northwest of Muskeget Island (Figure BA-12; Report No. 4.2.4-2). On a boat survey visit to the southern portion of the shoal study area on August 15, 2002, numbers of terns appeared to be flying toward Fernando's Fetch after sunset, presumably using the sandbar as an overnight roost. That season, the sandbar was estimated to be the size of a football field. Over 1,000 resting terns were observed there at a time with more terns arriving.

Refer to Section 5.1.1.2.3 for an estimated number of tern crossings of the Project area during the spring arrival and the breeding period in May and in June through July calculated by Hatch and Brault (2007), as well as an estimated number of annual tern crossings of HSS (Report No. 5.3.2-1).

Behavior and Flight Height

Of the 567 total terns observed during MAS boat surveys during the breeding period in 2003 and 2004, 297 (52 percent) were flying, 218 (38 percent) were feeding, and 53 (9 percent) were resting on the water. The terns observed flying during these boat surveys flew between 5 and 250 ft (1.5 and 76 m) with an average flight height of 29 ft (x m). Ninety percent of these flying terns were below 70 ft (21 m) (Perkins *et al.,* 2004a; Sadoti *et al.,* 2005a).

During MAS aerial surveys during the breeding season in 2003 and 2004, a total of 1,321 total terns were observed (Perkins *et al.,* 2004a; Sadoti *et al.,* 2005a). In 2003, 9 roseate terns were observed; three of which were foraging and six were flying (Perkins *et al.,* 2004a). That year, 199 terns were observed, of which 67.8 percent were foraging, 31.7 percent were traveling, and 0.5 percent were resting. During MAS' 2004 aerial surveys, 641 total terns were observed (53.5 percent were foraging, 45.4 percent were flying, 0.8 percent were resting on the water, and 0.3 percent were associated with vessels) (Sadoti *et al.,* 2005a). One tern was observed at 400 ft during the 2004 aerial surveys (Sadoti *et al.,* 2005a).

During the Applicant's 2003 aerial surveys, 1 roseate tern was observed at 23 m (75 ft) on Hawes Shoal in the southwest part of the shoals study area. For the 902 terns for which flight heights were categorized during aerial surveys in 2002 and 2003 by the Applicant, 822 (91 percent) were less than 20 ft, 16 (2 percent) were at 21-40 ft, 11 (1 percent) were at 41-60 ft, 1 (<1 percent) was at 61-80 ft, and 52 (6 percent) were greater than 80 ft (Report No. 4.2.4-3, 4.2.4-8, and 4.2.4-10). The 52 terns observed at rotor height on June 2, 2003 were near Monomoy.

During the Applicant's 2002 and 2003 boat surveys in the shoal study areas in 2002 and 2003, 176 total roseate terns were seen flying while 30 were seen resting on the water; 534 mixed-terns were seen flying while 1,253 terns were seen resting. During the Applicant's 2002 breeding season boat surveys, the flight heights of 1,779 flying terns were categorized: 1,732 flew within 60 ft (18 m) of the water's surface; and 47 terns were above 60 ft (18 m) (including terns that were seen flying after sunset to an overnight roost at Fernando's Fetch). A flock of terns was observed greater than 80 ft (24 m) and was estimated at 110 ft (33 m). During the Applicant's 2003 breeding period boat surveys, 1 roseate tern and 35 mixed-terns were observed less than 21 ft, while during these surveys roseate terns and mixed-terns were not observed at higher flight altitudes (Report No. 4.2.4-3, 4.2.4-8, and 4.2.4-10). During a boat survey in 2002, terns were seen flying toward overnight roost at Fernando's Fetch on August 1 and 15, 2002, on August 15, terns were seen flying higher than 18 m. HSS is located directly between this roost and major feeding areas to the north and northeast (Nisbet, 2005).

In summary, during the Applicant's breeding season surveys from 2002-2004, 100 total terns flew within the rotor zone, including one roseate tern at 75.5 ft (23 m) (USACE, 2004, Report No. 4.2.4-3, 4.2.4-8, and 4.2.4-10). The majority of terns observed by the Applicant were flying well below the proposed rotor zone (75.5 to 440 ft [23 to 134 m]), mainly below 39.4 ft (12 m) (USACE, 2004, Report No. 4.2.4-3, 4.2.4-8, and 4.2.4-10). During MAS boat surveys, of those terns observed flying in HSS, 3.2 percent of 130 traveling terns flew within the rotor zone in 2003, and 2.9 percent of 317 traveling terns flew within the rotor zone in 2004 (Perkins *et al.,* 2004a; Sadoti *et al.,* 2005a). The majority of terns were reported flying well below the proposed rotor zone.

4.1.3.2.2 Staging and Migration Season

After breeding, roseate terns move to staging areas in the vicinity of favorable feeding sites (Trull, 1998). Staging areas are where mixed flocks gather to rest between foraging activities during the day (Trull *et al.,* 1999). In the Northeast, the number of birds at staging grounds peaks during mid-August, though staging can begin as early as mid-June for some non-breeders or failed breeders (RTRT, 2007). Banded birds have been observed at staging grounds from 1 to 26 days (Shealer and Kress, 1994). The birds then disperse to their wintering grounds during

August and September. Roseate terns are known to travel far from their colony sites to staging areas, and sometimes travel north to staging areas before traveling south to wintering grounds. For example, Shealer and Kress (1994) reported staging and roosting roseate terns from 8 different colonies in the Northeast in August at Stratton Island, Maine. Terns that were known to breed in Maine and New York were observed at the South Beach staging location off Chatham, Massachusetts (Trull *et al.*, 1999). Cape Cod, Massachusetts, Sable Island off Nova Scotia, and Long Island, New York, also provide important staging habitat for the northeastern population. Because of the species' wide range of dispersal during the migration and staging periods, there is a potential that any individual from the northeastern population could occur in the vicinity of the area of proposed action over the course of a year.

Cape Cod, Massachusetts supports the largest pre-migratory staging habitat for roseate terns in North America (Trull, 1998). For example, during a peak survey conducted on September 1, 1998, 4,500 roseate terns were counted off of Cape Cod of which 3,850 were counted on South Beach in Chatham. Other known staging areas include sand flats or beaches located on South and North Monomoy Islands, Sandy Neck, Egg Island, Chapin Beach, and Jeremy's Point in Cape Cod Bay, Long Beach in Plymouth, Katama on Martha's Vineyard, South Cape Beach in Vineyard Sound, Smith and Eel Points and Harbor Jetties on Nantucket Island, and Tuckernuck and Muskeget Islands in Nantucket Sound, and Black Beach in Buzzards Bay (Trull *et al.*, 1999; NHESP, personal communication). Terns have occasionally been observed staging at Nauset Inlet on the east coast of Cape Cod and Hatch's Harbor at the northern tip of Cape Cod (Trull *et al.*, 1999; NHESP, personal communication). Figure BA-12 shows the tern pre-migratory staging locations that are located in Nantucket Sound and other surrounding areas.

Not all staging locations are used as nighttime roosting areas. Trull *et al*. (1999) observed that roseate terns only roosted at one of the staging areas in Nantucket Sound, South Beach (Figure BA-12). Sandy Neck in Cape Cod Bay was the other staging area observed to be used as a roosting site. During the staging period, terns arrive at roosting sites around sunset and continue to arrive after dark (Trull *et al.*, 1999). Terns are assumed to generally depart staging grounds before sunrise to travel to foraging locations. While dispersing, roseate terns may travel overland across Cape Cod, and they may pass over waters in Nantucket Sound to get from one region of the breeding range to another (RTRT, 2007).

Staging and Migration Season Aerial Surveys

<u>Location</u>

Surveys were recently conducted to document tern use of the area of proposed action during the fall staging and migration periods. In total, 37 aerial surveys and 36 boat surveys were conducted by MAS and the Applicant during the fall pre-migratory staging periods from 2002 to 2004 and in 2006. During the fall staging period, the Applicant's aerial surveys totaled 48 hours while MAS' aerial surveys totaled 99 hours. Boat survey hours during the Applicant's and MAS' fall periods totaled 32 and 21 hours, respectively.

MAS fall surveys documented a total of 16,550 tern sightings throughout the Sound. In 2002, 6 percent of the total terns observed were within of shoal study areas; in 2003, 8 percent were observed within the shoals; and in 2004, 7 percent were observed within the shoals (Perkins *et al.,* 2003; Perkins *et al.,* 2004b; Sadoti *et al.,* 2005b).

The Applicant's fall 2002 and 2003 aerial surveys documented a total of 10 roseate terns within the shoal study areas and 13 roseate terns outside of the shoals; 56 mixed-species terns within the shoal study areas and 2,966 mixed-species terns outside of the shoal study areas. During these surveys, terns were most commonly observed near Monomoy, Tuckernuck, and Nantucket Islands. Most flying terns observed during these surveys were foraging in flocks near Great Island, or traveling to or foraging at the fish weirs near North Monomoy (Report No. 4.2.4-9, 4.2.4-11)

During MAS' fall aerial surveys in 2002, tern abundance tended to be higher within a few miles of the south shore of Cape Cod, and relatively few terns were observed over HSS: of 5,721 total terns observed, 59.4 percent were near Monomoy (Perkins *et al*, 2003b). During MAS' 2003 aerial surveys, of 10,067 total terns observed, 61 percent were near Monomoy and 123 total terns (1.2 percent) were seen over HSS (Perkins *et al.,* 2004b). During MAS' fall aerial surveys in 2004, 823 total terns were observed of which 558 (71.2 percent) were close to Monomoy and 20 (2.5 percent) were observed over HSS (Sadoti *et al.,* 2005b).

Based on the combined data for all tern observations during the post-breeding staging and fall migration periods (August 7-September 25) during the Applicant's and MAS aerial surveys, the average density of terns observed in 2.6 km^2 (1 mi^2) grid cells within the total surveyed areas were calculated (based on the count of individuals along transects within a grid cell and the number of survey dates within each grid cell). All observations during this time period were included except for MAS' 2002 fall staging surveys because they did not use a specific survey width so the determination of density was not possible for these surveys. Within HSS, approximately 40 percent of the grid cells surveyed experienced an average density of 0 terns per square km (Report No. 4.2.4-2). Other areas in the shoal study area ranged in average density from 2 to 101-250 terns per square km (Report No. 4.2.4-2), with a higher average density of terns observed in grids at the southern boundary of the project. During the staging and migration period, there was a notable increase in the average density of terns in areas of Nantucket Sound, particularly over waters adjacent to the shorelines, as compared to the breeding season. The average density of terns during this period was greatest over the waters offshore of South Beach, Chatham and the Monomoy Islands and waters adjacent to the islands, with average densities of terns in this area of 7-10 to 251-450 terns per square km (Report No. 4.2.4-2). The waters offshore of Fernando's Fetch, and the waters offshore from the Town's of Mashpee and Barnstable also had survey grid cells with average densities of 101-250 terns per square km (Report No. 4.2.4-2).

Refer to Section 5.1.1.2.3 for an estimated number of tern crossings of the Project area during the staging and migration period from August to September calculated by Hatch and Brault (2007), as well as an estimated number of annual tern crossings of HSS (Report No. 5.3.2-1).

Behavior

During the Applicant's fall aerial surveys in 2002 and 2003, 1 common tern was observed at 70 ft (21 m) and was potentially within the rotor-zone. During the Applicant's fall boat surveys, 1 roseate tern was observed flying less than 21 ft and 16 mixed-species terns were flying less than 21 ft. In 2003, 139 terns were flying less than 20 ft, 3 terns were flying between 21 and 40 ft, and 1 tern was flying between 41 and 60 ft (Report No. 4.2.4-9, 4.2.4-11).

During MAS' fall aerial surveys in 2002, 5,721 total terns were observed with 634 roseate terns (59 percent of which were foraging, 39 percent of which were flying, and 2 percent of which were resting) and 3,311 mixed-species terns (35 percent were foraging, 46.8 percent were flying, and 18.1 percent were resting near Monomoy on exposed sandbars). On August 28, 2002, there were a number of high flying birds observed, including terns: a flock of 120 terns were observed a height ranges just above the water to greater than 500 ft and 18 common terns were observed kettling at 400 ft (Perkins *et al.,* 2003). During MAS' 2002 fall boat surveys, 42 total terns were observed over HSS; 19 were flying and 23 were feeding. Those flying terns occurred at height ranges of 5 to 50 ft (Perkins *et al.,* 2003). During MAS' 2003 aerial surveys, 10,067 total terns were observed including 376 roseate terns (51 percent were foraging, 48 percent were flying, and 0 percent were resting), and 7,899 mixed-species terns (68 percent were foraging, 29.7 percent were flying, 1.8 percent were resting, and 0.4 percent were associated with vessels) (Perkins *et al.,* 2004b). In 2003, 31 common terns and 45 mixed-species terns were between 300 to 500 ft). During MAS' fall aerial surveys in 2004, 823 total terns were observed: of 14 roseate terns seen, 1 was feeding and 13 were flying; of 717 mixed-species observed, 368 (51.3 percent) were foraging, 341 (47.3 percent) were flying, and 8 (1 percent) were resting on the water (Sadoti *et al*., 2005b). Most terns were observed above the surface of the water but their flight altitudes could not accurately be categorized. However on August 17, 4 terns were observed between 150 to 400 ft. During boat surveys in 2004, 1 roseate tern was seen flying and 18 mixed-species were seen flying, all between 10 and 75 ft; 1 unidentified tern species was seen between 75 and 425 ft (average height of 17 ft) (Sadoti *et al.,* 2005b).

J. Hatch (Report No. 5.3.2-1) and Nisbet (unpubl. obs.) have seen and heard mixed-species flocks of terns arriving at South Beach after sunset, descending from heights of 37-60 m (or higher). Nisbet (2005) notes that project area at HSS does not lie directly between the roosting area at South Beach and the daytime resting areas as described by Trull *et al.,* 1999; however, the parts of Martha's Vineyard from which terns would fly through the project area on a direct course to South Beach have not been surveyed.

An additional boat survey was conducted from August 28 to August 31, 2006, to observe the movement of terns near the staging area on South Beach and Monomoy Island. During these surveys, the average wind speed was 6 knots with winds from the northeast. The survey, conducted during 17.9 hours of observation and documented sightings of 932 common terns and 63 roseate terns commuting, foraging, or kettling (Report No. BA-1). During these surveys, a total of 966 commuting terns were observed. For the 966 terns for which height data is available, 250 of the heights were calculated and 716 were estimated. Overall, 89 percent of terns' documented flight altitudes were categorized as below the rotor zone (Report No. BA-1). A total of 380 terns (53 percent) flew at 3 m or below, 243 terns (34 percent) flew at 4-20 m, 43 terns (6 percent) flew at 21-50 m, and 50 (7 percent) flew at 21 to 100 m (Report No. BA-1). Of 357 terns flying upwind, 1 tern (0 percent flew within the rotor-zone (Report No. BA-1). The survey found that terns' flight directions into the wind influenced their flight heights: generally, terns flying downwind flew higher (33 m mean flight height), while birds flying upwind flew lower (4 m mean flight height). The exception was 1 of the 110 terns flying upwind which flew within the range of the proposed rotor-zone. Of 177 terns that flew within the rotor-zone, 70 terns (40 percent) flew downwind.

It was found that flight altitude decreased for terns flying upwind as wind speed increased (Report No. BA-1). The authors described the costs and benefits for terns flying in different wind speeds and different wind directions: birds flying upwind can decrease travel costs by not climbing and by flying in weaker headwinds close to the water's surface. Benefits of flying high downwind include stronger tailwinds (Report No. BA-1). Terns may conserve energy by taking advantage of stronger tailwinds at higher flight altitudes.

In order to further examine correlations between tern flight heights and wind speed, the authors of this BA used data collected during the periods when terns were present in the region in 2002 through 2004. Flight height data for 'flying' and 'commuting' terns (all tern species) collected during the Applicant's and MAS' aerial surveys were correlated to wind speed data, where possible. There were limited data for which wind speed, wind direction, and flight direction were available during the 2002 to 2004 surveys; therefore, this analysis was limited to relationships between wind speed and flight height. For the 14 survey dates included (when both flight height and wind speed data were available), wind speeds varied from 1 to 17 knots (average 7.1 knots). The analysis included observations of 1,152 individual terns.

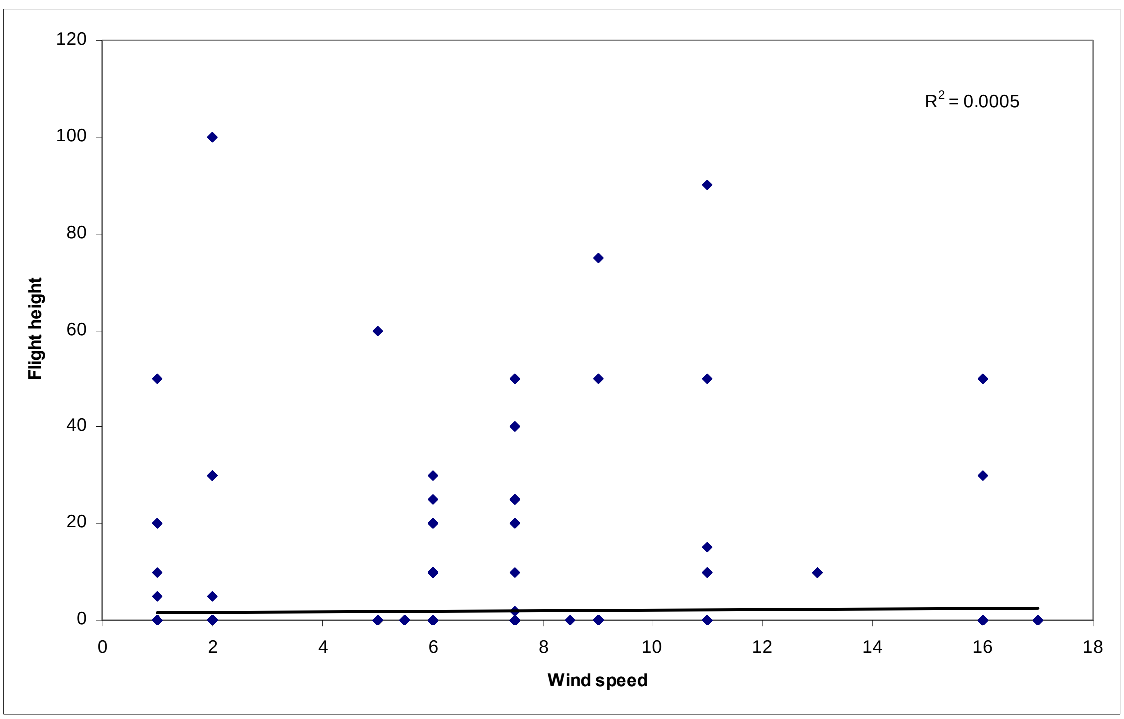


Figure BA-13.
Relationship between wind speed and tern flight heights from 2002-2004 (Applicant and MAS aerial surveys)

For this data set, the correlation coefficient, r, was 0.02, and the coefficient of variation (r2) was 0.0005, both indicating that there was little to no relationship between these two variables. The average wind speed for this dataset was 7 knots and the average wind speed for the Applicant's August 2006 surveys was comparable at 6 knots. Determining the relationship between wind speed and flight heights in a variety of wind speeds would require further investigation.

Summary

Similar to breeding season surveys, the majority of flight heights observed in the area of the proposed action during the fall occurred well below the rotor zone. During the 2002-2004 fall boat and aerial surveys, MAS observed only one tern flying within the rotor zone of the proposed turbines within HSS (Perkins *et al.,* 2003; Perkins *et al.,* 2004b; Sadoti *et al.,* 2005b). Aerial surveys conducted by the Applicant during fall 2003 indicated that of 143 terns for which flight altitude was estimated, 139 were less that 20 ft (6 m), three were between 21 and 40 ft (6 and 12 m), and one was between 41 and 60 ft (12 and 18 m) (Report No. 4.2.4-1). Boat surveys conducted that same fall indicated that of 1,679 common terns whose flight heights were estimated, 1,606 flew below 20 ft (6 m), 71 were between 21 and 40 ft (6 and 12 m), and one common tern was estimated at 70 ft (21 m) and was likely within the rotor zone. The flight height was estimated for a single roseate tern which was seen flying less than 21 ft (6 m). Of 16 unidentified terns for which flight heights were estimated during the Applicant's fall boat surveys, all were flying less than 21 ft (6 m) (Report No. 4.2.4-1). In summary, surveys conducted by the Applicant and MAS suggest that only 5 percent of traveling and foraging terns observed in the study area occurred at flight heights within the rotor zone (ESS 2007; Report No. 5.3.2-1). The results of MAS boat surveys indicate that the majority (95+ percent) of terns observed within HSS occurred at heights below the rotor zone (MAS, 2006).

The majority of tern observations in Nantucket Sound during the staging and migration seasons that were studied occurred outside of the shoal study areas (HSS, MHS, TS). Terns were generally concentrated around the mainland and island coasts of the Sound, particularly Monomoy Island during the late-August and early-September staging period (Report No. BA-1; Figure BA-12). During these seasons, HSS likely had the lowest level of activity out of any similar habitat surveyed in the Sound (MAS, 2006). Although the nesting locations of common and roseate terns are fairly stable, the number of breeding pairs present at specific locations changes, and the population fluctuates from year to year and, in recent years, for unknown reasons. Restoration efforts could result in additional changes to the number of breeding terns present at colony locations over time. Tern staging and foraging locations are dynamic. If the locations of colony sites, staging areas, or heavily used foraging areas change, the occurrence and density of roseate terns in HSS could change. A specific example is the transient sand bar known as Fernando's Fetch (10 miles [16 km] south from the nearest edge of the project) which, when present, provides roseate terns with roosting habitat. If this sand bar is more sizable during certain years, Nisbet (2005) suggests that its importance as a roosting site could increase and it could potentially be more heavily used than South Beach as it is more secure from nocturnal human disturbance and nocturnal predation.

Refer to Section 5.1.1.2.3 for an estimated number of tern crossings of the Project area during the spring arrival and the breeding period in May, and in June through July, and during the post-breeding and fall staging period from August through September as calculated by Hatch and Brault (2007), as well as an estimated number of annual tern crossings of HSS (Report No. 5.3.2-1).

4.2 Factors Affecting Species' Environments within the Action Area

4.2.1 Federal Actions

Pipelines and Cables

Presently, there are three existing submarine cable systems located in Nantucket Sound that interconnect the mainland with the offshore islands to provide reliable island-wide power supply. There are no current proposals for new submarine pipelines in the Nantucket Sound area. One cable system interconnects Falmouth, on the mainland, to Martha's Vineyard at Vineyard Haven on the westerly side of Nantucket Sound approximately 13 miles (21 km) to the west of the proposed action's locus. The other two submarine cable systems connect the mainland transmission system from Harwich and Barnstable (Lewis Bay) to Nantucket Island located approximately 8 mile (13 km) east of the proposed action's locus. The first submarine solid dielectric cable system was installed in 1995 and the second system was installed in 2006. The Martha's Vineyard Island submarine cable systems have been in place for decades, with the most recent replacement cable installed in the seabed off of Falmouth in 1997. There are no publicly available plans at this time for any future submarine cable system installations in Nantucket Sound except for those associated with the proposed action.

The other two known, large offshore pipeline projects that could potentially be constructed in Massachusetts include two Liquefied Natural Gas (LNG) projects with submarine gas pipelines, both of which require federal agency approvals. The one proposed by Excelerate, Northeast Gateway, has been permitted and has recently completed construction. The second, proposed by Neptune Energy is expected to begin construction in mid-2008. These projects are located far from the proposed action within Massachusetts Bay and would not have affects overlapping with the species populations or habitats in the area of the proposed action.

Navigation Features

There are two main shipping lanes, the Main Channel and the North Channel, used for safe navigation by larger vessels in Nantucket Sound. USCG marks both of these areas with aids-to-navigation (buoys, lights, etc.). These shipping lanes are described as follows:

The Main Channel starts in the West at the juncture of Vineyard Sound and Nantucket Sound at Nobska Point, passes north of West Chop and East Chop on Martha's Vineyard, and passes south of Hedge Fence shoal. It then continues in a Southeasterly direction passing between Horseshoe Shoals (the proposed action) to the North, and Hawes Shoal (Chappaquiddick Island) to the South. The channel is fairly wide in most areas being approximately 1.1 mile (1.8 km) across from edge to edge as marked on NOAA Chart 13237 for a draft of 30 ft (9.1 ft). It constricts down to approximately 0.85 miles (1.4 km) wide directly south of Horseshoe Shoal at Cross Rip Shoal. It widens soon after heading eastward and immediately south of Half Moon Shoal hosts the channel heading toward Nantucket Island. The Channel width for the Nantucket Harbor is approximately 0.86 miles in width. The Main Channel continues and turns East Northeast and then Northeast heading for the south of Monomoy Island and Butler Hole which provides the deep water for the channel as it bisects Monomoy Island and Bearse Shoal to the north and Monomoy Shoal to the South. The channel passage through this area is narrow. It is reported that vessels using the channel seldom exceed a draft of 24 feet (7.3 meters) (NOAA, 1994).

The other major channel is called North Channel which skirts the south of Cape Cod and provides access to ports along the Cape Cod shore such as Falmouth, Hyannis, Yarmouth and Chatham. This channel runs north of Horseshoe Shoal and runs in an East-West direction. The channel is well marked by aids to navigation and has a restricted depth of 16 ft (4.9 m).

This channel is used mostly by vessels bound for the south shore of Cape Cod, and by vessels transiting the Sound during northerly winds. The shallowest depth in the channel is approximately 16 ft (4.9 m) at Mean Lower Low Water (MLLW).

In addition to these shipping channels, privately and federally maintained channels are located at the approaches to Cotuit Bay, Centerville Harbor, and Hyannis Harbor (see Figure 4.3.2-1).

The area between the Main Channel and the Cape Cod shoreline, including Horseshoe Shoal, is designated as an anchorage ground, known as "Anchorage I." Floats or buoys for marking anchors or moorings in place are allowed in this area. Fixed mooring piles or stakes are prohibited (NOAA, 1994).

It is possible that additional dredging may occur at shore-based marinas supporting boating activities throughout the area of the proposed action. Hyannis Harbor was dredged in 1985, 1991, and 1998. No future dredging activities are currently scheduled. However, future USACE maintenance dredging in Hyannis Harbor would be the subject of an additional NEPA document.

Given that the shore side facilities proposed for use by Cape Wind have adequate channels to accommodate the necessary vessels during construction, operation and decommissioning, it is unlikely that any channel maintenance will occur in association with the proposed action.

Although oil tanker trips near the proposed action are infrequent, the presence of WTG and ESP foundations in the vicinity of oil tanker shipping lanes increases the risk of ship collisions, and possibly oil spills. The contents of tankers may be released, or fluids contained within the ESP or WTG structures could be released. However, that the likelihood of an oil spill as it relates to the Cape Wind project is drastically reduced due to the minimal shipping traffic that takes place in the vicinity of Horseshoe Shoal. As can be seen in Section 4.4.3 of the DEIS, Nantucket Sound is not a main thoroughfare for commercial shipping, like Buzzards Bay. In addition, the DEIS stated, "The location of the site of the proposed action relative to established vessel routes, physical water depth restrictions on Horseshoe Shoal and the large WTG grid spacing combine to limit the potential for a vessel to collide with a WTG". Spills unrelated to the proposed action may occur in the region and result in cumulative effects to avian species. Oil spills can impact large areas if the spills are not immediately contained. The coastline of Buzzards Bay was impacted when the *Bouchard No. 120* collided with rocks off the coast of Westport in 2003. Oil was reported as far as Block Island and Middleton, Rhode Island (BBNEP, 2003). At least three adult roseate terns were found dead with traces of oil. Roseate terns were discouraged from nesting on Ram Island in 2003 because it was soiled from the oil spill. Consequently, 250 pairs nested on Penikese Island that year and productivity suffered due to the late initiation of egg-laying (BBNEP, 2005). Piping plover were impacted by the oil spill, particularly at Barney's Joy, Dartmouth. Two piping plover were reported dead as a result of oil slicking. However, piping plover nesting success in the area that year was not believed to be adversely impacted (BBNEP, 2003).

Beach Nourishment and Wildlife Habitat Management

Population management efforts for terns and shorebirds of conservation concern have involved the initiation and regulation of beach restoration activities in the region by various Federal Agencies. These activities have included beach nourishment, erosion control, and vegetation management at beaches that provide important habitat to nesting and staging species of conservation concern. Within the area, beach nourishment activities have occurred at (but are not limited to) the following beaches: Harding Beach in Chatham, Seagull and Great Island beaches in Yarmouth, and West Dennis and Sandwich beaches in Barnstable. The New Bedford Harbor Trustee Council has allotted over 500,000 dollars for the restoration of severely eroded Bird Island, one of the most important roseate tern breeding areas in the region. Timing of restoration activities is uncertain (MDFW, personal communication). At a beach in Duxbury, efforts have been made to maintain piping plover habitat by controlling vegetative growth. Vegetative control may involve the active removal of vegetation, however, in Duxbury, the deposit of sandy soil on beach grass has effectively promoted the presence of nesting piping plover. Beach nourishment can enhance breeding and foraging habitat for piping plover, pending on management of recreational activities, otherwise the nourishment is futile. Other wildlife habitat management efforts include the use of fencing and signs to prevent beach goers from entering nesting areas. At important avian breeding areas such as the Monomoy Island National Wildlife Refuge, access to shorebird and tern nesting areas is restricted to pedestrians for the duration of the breeding season.

4.2.2 State and Private Actions

Commercial Fishing and Shipping

A commercial fishing survey, conducted in the late summer, early fall of 2005 consisted of 18 surveyed commercial fishermen who owned a total of 21 boats that commercially fished Nantucket Sound for at least part of an annual fishing season. Of these boats, 16 (76 percent) hauled mobile gear and 5 (24 percent) hauled fixed gear. The reported mobile gear types utilized in Nantucket Sound among the survey group include trawlers (13 boats, also called draggers which drag the sea floor), and hook and line (3 boats). Fixed gear types included pots and traps

(4 boats), and gill nets (1 boat). Three of the 21 boats reported fishing in Nantucket 100 percent of the time and eight fished in Nantucket Sound the majority of the season.

Various sources documented that over 70 fishing vessels varying from 30 to 60 ft (9.1 to 18.2 m) in length and 4 to 8 ft (1.2 to 2.4 m) in draft fish Nantucket Sound. Other references postulate that local fisherman attribute 50 to 60 percent of their livelihood to fishing Nantucket Sound. Actions by NMFS reducing "days-at-sea" by 40 percent average for ground fish may result in fishing vessels that fished away from the area returning to the Sound to comply with the at sea reduction to fill their ground fish quotas. It is also documented that 200 to 250 commercial fishing vessels, many from New Bedford, MA use the Main Channel across Nantucket Sound to gain access to fishing grounds on Georges Bank and elsewhere. These vessels range in size from 60 to 100 (18.3 to 30.5 m) feet in length and have drafts of 8 to 15 ft (2.4 to 4.6 m).

The main vessel traffic patterns follow the Main Channel and North Channel. The numerous shoals in Nantucket Sound limit the operating areas for vessels depending on the vessel's draft. Charted water depths on Horseshoe Shoal range from one foot to 45 ft (13.7 m) measured at Mean Lower Low Water (MLLW). The majority of the Shoal is 20 to 30 ft (6.1 to 9.1 m) at MLLW. Analysis of the vessel make-up by type, size and service shows that only one quarter of Horseshoe Shoal has depths that allow the majority of the vessel types using the area to operate and/or drift without going aground.

Ferries out of Woods Hole and Hyannis servicing the Islands of Martha's Vineyard and Nantucket use the North Channel (Falmouth and Hyannis) and then the Main Channel for their transits to and from the ports of Vineyard Haven and Oak Bluffs. Ferries operating out of Rhode Island enter the Nantucket Sound through Vineyard Sound and pick up the Main Channel at Nobska Point for their transits to Martha's Vineyard and Nantucket. Those Ferries transiting to Nantucket will follow the Main Channel until the Nantucket Channel Intersects in the vicinity of Half Moon Shoal. There are not any major or significant Port Facilities that handle large deep draft traffic and are engaged in commercial cargoes in the vicinity of the proposed action. The closest Port Facilities that handle significant quantities of commercial products including containers and bulk cargoes are located in Providence, RI, Boston, MA and to a lesser extent New Bedford, MA. Deep draft ship traffic carrying containers and bulk cargoes do utilize Buzzards Bay for access to the Cape Cod Canal.

Commercial fishing and shipping do occur within the area used and occupied by the listed species of concern dealt with in this Biological Assessment. Therefore, potential impacts from these activities do overlap in space and would overlap in time, and therefore represent impacts to the baseline conditions for all listed species covered herein. Even commercial shipping within Buzzards Bay has potential affects, since the nesting area for roseate terns that occur in the area of the proposed action, are located in Buzzards Bay. It is well documented that ghost fishing nets get entangled with sea turtles and whales, causing harm and mortality. Similarly, a major source of mortality for whales comes from collisions with commercial ships. Therefore, the environmental baseline conditions of the area of the proposed action include pre-existing impact factors for all the listed species.

Recreational Fishing and Boating

Because of its location adjacent to several key vacation destinations (i.e., Cape Cod, Nantucket, and Martha's Vineyard), Nantucket Sound and the waters around the islands of Nantucket and Martha's Vineyard support a diverse array of recreational fishing activities. Results from the NMFS Marine Recreational Fisheries Statistics Survey (MRFSS) from three counties surrounding Nantucket Sound (Dukes, Barnstable, and Nantucket) from 1990-2004 were summarized. In those fifteen years there have been 40,130 MRFSS surveys reported from Dukes, Barnstable, and Nantucket Counties. It is important, though, to note that the data obtained from these surveys cannot be directly related to Nantucket Sound. Even though the surveys were conducted in the counties surrounding the Sound, only a portion would have been engaged in recreational fishing activities in Nantucket Sound because these surveys likely include anglers engaged in fishing activities offshore, in waters further out on the Cape, further offshore to the south of Nantucket and Martha's Vineyard, or even in portions of Buzzards Bay.

The various fishing gear reported by surveyed anglers included hook and line, dip/A frame net, cast net, gill net, seine, trawl, trap, spear, hand, or other. The majority surveyed (99.7 percent) reported hook and line as gear type used for recreational fishing. The use of a dip net ranked second in terms of gear used (0.105 percent). Some type of fish trap use was reported in only 20 of the 40,079 surveys from 1990 through 2004. Gill nets were reported one time over the fifteen-year period.

The Cape Cod, southern Massachusetts, Rhode Island and Martha's Vineyard and Nantucket areas are home to thousands of small craft, both power and sail and host to hundreds more cruising the waters of Nantucket Sound during the summer months (May through October). Significant recreational traffic can be found in the Ports of Hyannis, Chatham, Dennis Port, Harwich Port, Yarmouth, Falmouth and Woods Hole as well as the many inlets, bays and backwaters in between. On the Islands, harbors frequented by pleasure craft include Vineyard Haven, Oak Bluffs and Edgartown while on Nantucket Island they include Nantucket Harbor. These port facilities mainly consist of yacht clubs and marina type environments that are made up of small boat piers and quays and mooring areas for recreational boats and fish offloading and processing equipment for the commercial fishing fleet.

These types of activities are very spread out throughout Nantucket Sound and while they may affect a listed species, the effects are probably discountable or insignificant to minor. For instance, fishermen that discard fishing line into the ocean can cause entanglement of feeding roseate terns. If bait or catch waste products are left at the shoreline by fishermen, this activity could attract predators to piping plover nesting areas. Recreational boaters could strike a surfacing sea turtle. Therefore, while unquantifiable, there is likely some adverse effects of recreation that could overlap or be additive with potential impacts from the proposed action, or at a minimum, cause affects within the baseline conditions of the area of the proposed action.

Coastal Recreational Activities

Humans enjoy multiple uses of the coastal habitat within the region. An increase in human recreational activities in the later half of the 1900s is believed to be associated with a nearly 50 percent increase in growth within Atlantic and Gulf Coast States, as well a general shift toward more prosperous and relaxed life styles (USFWS, 1996). Recreational activities include pedestrian and vehicle uses of beaches.

The Cape Cod National Seashore experienced increases in the number of visitors from 2,830,000 visits to 4,979,000, in 1966 and 1981 respectively (USFWS, 1996). Based on information provided by the Monomoy Refuge Management Information System, it was estimated that 115,000 to 135,000 persons per year visit the National Wildlife Refuge for fishing, wildlife viewing, beach or water uses (Unsworth *et al.,* 2000).

The use of vehicles on beaches in the region peaked by the beginning of the 1980s. For example, in 1981, 2,234 ORV permits were provided for use on Sandy Neck, in the towns of Sandwich and Barnstable; by 1989, 4,000 ORV permits were granted at Sandy Neck (USFWS, 1996). In 1989, the Cape Cod National Seashore issued 2,338 ORV permits, and 290 permits for self-contained camping vehicles (USFWS, 1996). In recent years the use of vehicles has been restricted. Beaches within the region that vehicle use permits can be acquired for include (but are not limited to) the following beaches within the region: Sandy Neck Beach, Sandwich and Barnstable; Nauset Beach in Orleans; and Chapin Memorial Beach in Dennis. Vehicle use on beaches that support piping plover nesting can result in conflicts with the plover, including running over nests or chicks. In other instances high vehicle use can interfere with foraging activities, causing a decrease in foraging success and reduced body weight or in extreme conditions starvation or abandonment of young.

The current level of management of recreational activities at plover nesting beaches is necessary to maintain the population and to encourage an increase in the population trend (USFWS, personal communication).

4.2.3 Other Potential Sources of Impacts in the Environmental Baseline

OCS Alternative Energy

Other reasonably foreseeable offshore alternative energy projects include Tidal In-Stream Energy Conversion (TISEC) Devices, other offshore wind turbines, and wave turbine technology. TISEC devices are a similar technology to wind turbines except that they are installed in the water column and are moved by underwater tidal currents. At present, one such project is proposed in Vineyard Sound, approximately 10 miles away from the area of the proposed action.

There are currently 804 MW of commercial offshore wind power in Europe, with many proposed projects in the United States (Musial, 2006). With the ever-increasing demand and cost of energy, and the excellent-to-outstanding wind resources on the northern part of Cape Cod, the southern part of Cape Cod, and along the shore of Martha's Vineyard and Nantucket (according to the DOE Energy Efficiency and Renewable Energy (EERE)) the potential for further wind energy development is high.

Wave turbine technology can be defined as a system of reacting forces, in which two or more bodies move relative to each other, while at least one body interacts with the waves. At present no wave turbine projects are proposed in the area of the proposed action.

Currently there is only one tidal energy project proposed in the general area of the proposed action. This is proposed by Cape and Islands Tidal Energy Company and is located in Vineyard Sound. While the tidal energy project is more than 10 mile (16 km) away from the area of the proposed action, it does occur in an area that is used and traversed by sea turtles and roseate terns that may also occur in the area of the proposed action.

Effects from the wind project in Buzzard's Bay proposed by Patriot Renewables, LLC could overlap with potential affects of the proposed action, since species such as roseate tern and some of the sea turtles are likely to be found in both areas. Firm plans for the construction and operation of the Patriot Renewables' wind project have not been announced and it is unclear if such an interaction would ever develop.

Sand Mining and Mineral Extraction

Presently, there are no sand mining projects proposed within the area of the proposed action; however the demand for sand to nourish eroding beaches has risen in recent time and will be expected to increase given the rising sea levels and eroding shorelines. For example, there is one proposal for an offshore sand mining project in the vicinity of Nantucket Sound. The Sconset Beach Nourishment Project is proposing a 345 acre (140 hectare) dredge site approximately 3 mile (5 km) east of Nantucket Island just outside the Cape & Islands Ocean Sanctuary. NMFS has issued a non-jeopardy biological opinion under the ESA on the Sconset project. The proposed action is currently under MEPA review and is contingent upon approval and licensing from several other state and federal agencies including Mineral Management Service (MMS) and U.S. Army Corps of Engineers (ACOE). Sand dredging for the Sconset Beach Nourishment Project could have overlapping affects with some of the listed species, such as sea turtles foraging in the area, or piping plovers foraging on the beach. The same populations of sea turtles, whales, roseate tern, and piping plover could occur in both locales and could be influenced by impacts from both projects.

There is a current moratorium on oil and gas drilling off of the Atlantic coast with extended protections set to last until 2012, so no impacts to protected species currently occur in the baseline setting due to oil and gas drilling or well development.

Communication Towers and Other Tall Structures

As areas of Cape Cod are heavily developed and thickly settled, there are numerous communication towers such as cell phone towers, radio towers, and airport towers. The presence of tall buildings is less common in the area of the proposed action than in some other areas of coastal New England. These types of structures have been documented as a major source of mortality for many species of birds. While possible, this is less of an issue with the roseate tern and piping plover since a majority of their flying time is over water or along the waters edge, where these structures are uncommon.

Residential and Commercial Coastal Development

The region is characterized by thickly settled residential areas, commercially developed areas, as well as fragmented forests, and sections of protected natural lands. There are numerous waterfront properties; as well as break waters, jetties, seawalls, and groins that have been built to protect erosion of waterfront properties, and to prevent sedimentation of rivers and channels. This development represents human induced alteration of habitats that historically have been used by many birds, including the roseate tern and piping plover. As described elsewhere, feral or uncontrolled house pets are a source of mortality for piping plover on area beaches. Increased residential and tourist housing has resulted in increased human activity on area beaches, to the detriment of nesting and foraging piping plovers.

Military Training

There are no designated naval training areas within the area of the proposed action and submarine activity could not occur within Horseshoe Shoal due to insufficient depths. The Massachusetts Military Reservation conducts military training in the vicinity of the proposed action, but whether these activities affect populations or habitats of listed species is unknown.

4.3 Mitigation and Conservation Measures Contributing to the Environmental Baseline

Mitigation and conservation measures contributing to the environmental baseline are discussed below. Additional mitigation and monitoring applied to the proposed action can be found in Section 8.0.

4.3.1 Cetaceans

Off the southeastern Massachusetts coast, Critical Habitat has been designated for the Northern Right whale in order to allow for additional management opportunities for this dwindling species. These areas are located north (Cape Cod Bay Northern Right Whale Critical Habitat Area) and east of Cape Cod (Great South Channel Northern Right Whale Critical Habitat Area) and do not include Nantucket Sound. The western edge of the Great South Channel Right Whale Critical Habitat Area is located about 25 miles (40.2 km) east of Nantucket.

In addition, the NOAA Fisheries has created a Mandatory Ship Reporting Area (MSRA) that essentially encompasses the Great South Channel shipping lane starting southeast of Nantucket and extending into Boston Harbor. Within this area, the U.S. Coast Guard operates the mandatory reporting system (WHALESNORTH) that allows the U.S. Coast Guard to remain apprised of North Atlantic right whale movements within the area relative to ship positions. Large vessels entering the MSRA report their activities to WHALESNORTH so that there is coordination in the movement of large ships relative to reported whale sitings.

4.3.2 Sea Turtles

Since one of the largest sources of mortality for certain sea turtle species results from interaction with commercial fishing vessels and gear, NOAA Fisheries, conservation groups, and the commercial fishing industry have been working to develop methods and gear that reduce the incidental capture or harm to sea turtles. Because of the relatively infrequent occurrence of sea turtles within Nantucket Sound, and even within the Cape Cod region, much of this effort has focused on more tropical and sub-tropical locations where the abundance of sea turtles is higher and therefore there are more interactions between sea turtles and commercial fishermen. However, these efforts generate benefits for sea turtles at a global population level, and could result in benefits to those species that occur in the area of the proposed action.

Other conservation measures have targeted conservation and preservation of nesting beaches, and thousands of volunteers around the globe participate in nest protection and other activities on tropical beaches during the nesting season. These efforts are intended to increase survival of eggs and hatchlings in an attempt to increase the success of getting hatchlings into the ocean, to offset other mortality factors faced by sea turtles.

4.3.3 Birds

4.3.3.1 Piping Plover

Piping plovers in Massachusetts, and across their range, are monitored and managed by a cooperative group of biologists, beach managers, researchers, and volunteers (Mostello and Melvin, 2002). Local conservation efforts at breeding sites across the piping plover's range include closing portions of beaches where birds are nesting, construction of predator exclosures around nests, avian and mammalian predator control, mitigation of water level regulation policies, vegetation control, and, in some cases, creation of artificial habitat (Haig and Elliott-Smith, 2004). Management techniques are continually assessed and refined to increase breeding success. Recovery programs have focused chiefly on increasing productivity and survival during the breeding season.

Within Massachusetts, all nesting locations are monitored as several times per week or more frequently, except for island locations including Tuckernuck, Muskeget, and Cuttyhunk where access is limited. These sites are monitored 1 to 2 times during the breeding season. Symbolic fencing (posts and twine and signs) are used at nearly all breeding locations to discourage human and pet activity around nests. Predator exclosures have been employed at most nesting beaches in Massachusetts; however, their use is situational depending on the location of nests in relation to dune vegetation as well as predatory behavior. On the Monomoy Islands, areas with active or historical nest sites are posted off limits to pedestrians during the entire breeding period. Gull control methods have been targeted for gulls that use Monomoy Island and South Beach. At several nesting locations, predators including feral cats have been trapped and removed. Management efforts at a few beaches including Harding Beach, Chatham have targeted beach nourishment activities. Several locations including Chappaquiddick Island, off of Martha's Vineyard; Cuttyhunk Island; The Galls; Gooseberry Neck; Plymouth Beach; Barney's Joy; and Smith Point have made efforts to limit vehicle access to nesting areas (USFWS, 1996).

Critical habitat has not been designated for Atlantic Coast breeding locations, however, southern wintering grounds, including areas within North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas, are protected. There are certain beach use restrictions on activities such as construction and beach nourishment that apply to designated critical habitat areas.

4.3.3.2 Roseate Tern

The Northeast population of roseate terns was listed as Endangered in 1987. The recovery goals are to restore the northeastern breeding population (U.S. and Canada) to 5,000 pairs that breed among 6 or more large colonies (i.e., greater than 200 pairs) within the current breeding range, and to maintain a high average productivity (1.0 fledgling per pair for 5 consecutive years) at each of these breeding locations. Delisting of the population will only be an option if the number of breeding pairs reaches the historical level of 8,500 pairs (USFWS, 1998).

Critical habitat was not designated at the time of listing because most nesting sites in the U.S. are on islands that are already protected as National Wildlife Refuges or Parks, or are under state or local government jurisdictions. In Massachusetts, Bird Island, is owned by the Town of Marion and officially managed by the Harbormaster’s Office and the Conservation Commission and is designated a bird sanctuary; the island’s terns are managed by the Massachusetts Division of Fisheries and Wildlife (MDFW); Ram and Penikese Islands are Wildlife Sanctuaries owned and managed by the MDFW; and the Monomoy Islands are within the National Wildlife Refuge system. Additionally, due to the dynamic nature of roseate tern foraging pre-migratory staging, and breeding locations, it was determined that establishing critical habitat would not be effective for an extended period of time (USFWS, 1987); however, recent trends indicate that breeding locations are fairly stable.

Roseate tern colonies are monitored by biologists that either live on the islands or regularly visit them. Research activities have included trapping, banding, and color marking adults and chicks; monitoring of nest, eggs, and chicks; monitoring of chick growth, survival, and productivity; and re-trapping of adults on wintering grounds.

Conservation efforts have been directed toward attracting common tern colonization because roseate terns that breed in the Northeast have only colonized sites inhabited by common terns (Nisbet and Spendelow, 1999). These efforts have included controlling or prohibiting human recreational activity in the vicinity of colony sites by fencing; vegetation management at colonies; the placement of artificial nest cover including nest boxes and half-buried car tires at nesting sites; efforts to prevent erosion; and the control of competitor gull species. Efforts have also been taken to control predation including the removal or relocation of great horned owl (*Bubo virginianus*), black-crowned night-heron (*Nycticorax nycticorax*), and peregrine falcon (*Falco peregrinus*). In Massachusetts alone, hundreds of thousands of dollars have been invested in tern restoration efforts (Spendelow *et al.,* unpublished). As of 1999, island restoration and management activities resulted in the establishment of breeding roseate terns at 5 islands (Nisbet and Spendelow, 1999). Previous restoration activities have been limited by funding and site accessibility.

5.0 EFFECTS OF THE ACTION

The ESA defines prohibited take of listed animals as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." The ESA defines harass as "…an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly impair normal behavioral patterns including breeding, feeding or sheltering" (50 CFR 17.3) and harm as "… significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering" (50 CFR 17.3). The MMPA of 1972, as amended, defines harassment as any act of pursuit, torment, or annoyance that has the potential to injure a marine mammal or marine mammal stock in the wild (Level A Harassment) or has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption to behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (Level B Harassment) (16 U.S.C. 1362(18)(A)). Although activities that harass do not rise to the level of immediate injury or mortality, they still need to be analyzed in the context of the effect, both short- and long-term, of the disruption on critical natural behaviors. For example, of particular concern are disruptions to individuals or populations that may manifest as an animal that fails to feed successfully, breed successfully (which can result from feeding failure), or complete its life history because of changes in behavioral patterns. Similar categories of harassment can be applied to listed bird species, although the actual mechanism could be different from those associated with whales or sea turtles.

Potential effects on listed species or critical habitat may occur either from routine activities or from accidental events and may be direct or indirect. Discussed below are general sources of potential impacts to protected species and/or critical habitat from the proposed action. Following that, more specific impact factors related to individual species are included. Lastly, taking into account the current environmental baseline, species status, and existing mitigation measures, an impact determination is made for each listed species and designated critical habitat.

Anticipated impacts to biological resources from the proposed action are categorized as no adverse effects or likely adverse effect. The impact levels are defined as follows:

(1) No Adverse Effect

- Discountable, insignificant or beneficial effects.

(2) Likely Adverse Effect

Minor

- Most impacts to the affected resource could be avoided with proper mitigation, or
- If impacts occur, the affected resource would recover completely without any mitigation once the impacting agent is eliminated.

Moderate

- Impacts to the affected resource are unavoidable, and
- The viability of the affected resource is not threatened although some impacts may be irreversible, or
- The affected resource would recover completely if proper mitigation is applied during the life of the proposed action or proper remedial action is taken once the impacting agent is eliminated.

Major

- Impacts to the affected resource are unavoidable, and
- The viability of the affected resource may be threatened, and
- The affected resource would not fully recover even if proper mitigation is applied during the life of the proposed action or remedial action is taken once the impacting agent is eliminated.

5.1 Whales

Potential impacts to listed whale species can occur from planned, routine, or anticipated impacts during all three phases of the proposed action, construction, operation, and decommissioning. In addition, there are several potential impacts that could occur as a result of accidental or unplanned events.

5.1.1 Whales-Routine Activities

The major impact-producing factors affecting whales as a result of proposed action activities include noise associated with construction, operation and decommissioning activities, vessel traffic, changes in water quality, and habitat.

5.1.1.1 Construction and Operational Noise

Studies show that the maximum submarine sound generated during the construction and operation of the Wind Park will occur during installation of the monopile foundations. Measurements taken during pile driving of five smaller offshore windparks in the United Kingdom document that noise levels varied between 243 and 257 dB re 1µPa @ 1 m, having an average value of 250 dB re 1µPa @ 1 m (Nedwell *et al.*, upubl. data). Noise from pile driving operations can remain above the background noise to ranges of 25 km or more but can also diminish within 10 km, dependent on the local environmental conditions ((Nedwell *et al.*, upubl. data).

Additional sound source data for construction and operational effects underwater were provided by GE Wind Energy from recent tests at the Utgrunden Project in Denmark which has similar environmental conditions to Nantucket Sound, and the size of the monopiles and the installation techniques proposed for this proposed action are the same as for the Utgrunden Wind

Park (Report No. 4.1.2-1). The Utgrunden data show a maximum sound level of 178 dB at 1,640 ft (500 m) with peak energy from pile driving at 315 Hz, and with underwater sound levels falling below background levels (inaudible) for frequencies below 5 Hz.

The jet plow embedment process for laying the two submarine cable circuits and inner-array cables produces no sound beyond that produced by typical vessel traffic and the cable installation barge will produce sound typical of vessel traffic already occurring in Nantucket Sound. No substantial underwater sound will be generated during horizontal directional drilling (HDD) operations used to transition the submarine cable to the upland cable system in Lewis Bay. Due to the sound-insulating qualities of earthen materials (the sediment), and the fact that the drilling would take place through unconsolidated material, the HDD transition is not anticipated to transmit vibration from the sediment to the water (i.e., it would not add appreciable sound into the water column).

The sound source level for a tug and barge traveling at low speed, the typical construction and maintenance vessels for this proposed action, is 162 dB at one meter (Malme *et al*., 1989).

Pile Driving

In general, toothed whales have a hearing bandwidth of 100 Hz to over 100 kHz, with the most sensitive hearing in the HF range of 10 kHz to 65 kHz where their hearing threshold is 40 to 60 dB (Richardson *et al.,* 1995). Baleen whales react primarily to sounds at low frequencies below 1 kHz, which is consistent with the fact these whales usually communicate at frequencies in the 20 Hz to 500 Hz range (Richardson *et al.,* 1995). The hearing threshold for baleen whales ranges from 82 dB at 500 Hz to 88 dB at 20 Hz (Nedwell *et al.,* 2004).

Measurements of actual underwater sound levels taken during the construction of the five offshore windparks in the United Kingdom indicate that there are two areas at which protected whales may be adversely impacted, the area of noise injury and the area of behavioral effect. (Nedwell, *et al*. unpub. data). Physical effects (injury) to whales may occur at a distance when dB_{ht}=130 re 1μPa, while behavioral effects (avoidance) may occur at a distance when dB_{ht}=90 dB re 1 μPa (Nedwell, *et al*. unpub. data). The area in which physical injury could occur may extend to a few hundred meters from the piling driving operations, while the area in which behavioral changes may occur may extend to a kilometer or greater (Nedwell, *et al*. unpub. data). Therefore, based on the mitigation and monitoring measures required during pile driving activities for the proposed action, although marine mammals may hear the underwater construction sounds they are not expected to cause physical harm to cetaceans (See Section 8.1.2 and 8.1.2). Table 4 presents summary information of pile driving activities and equipment. MMS recommends that the applicant contact NMFS to determine if an IHA under the MMPA is warranted. If an IHA application is submitted, the final IHA would need to be issued prior to the commencement of any activities that may "take" marine mammals.

Table 4.
Summary of Pile Driving Activities and Equipment

Number of Piles Driven	130
Duration to Drive a Single Pile	4 hours of driving; takes 24 hours to cycle through one pile driving from setting barge in place, completing driving of one monopile to moving barge to next site and setting down legs
Number of Piles Driven per Week	4
Time of Year of the Activity	year round, projected to start in late winter
Total Duration of the Pile Driving Portion of Project	monopiles and scours will be installed over a 400 day period
Diameter of the Piles	water depth 0-12.2 m use 5.1 m diameter monopile and 12.2-15.2 m water depth uses 5.5 m diameter monopile
Depth of Driving	approximately 26 m for turbine monopiles and 46 m for ESP piles
Material Composition of the Piles	tubular conical steel tower
Equipment Used	jack up barge, crane, transport barge, pile driving ram or vibratory hammer
Type of Pile Driving Method	IHC S-1200 hydrohammer (vibratory hammer) or pile driving ram [for monopiles] and IHC S-500 hydrohammer for ESP
Size of Hammer	IHC S-1200: weight [ram=60, hammer with ram in air= 138]; dimensions [outer diam. hammer= 1625, hammer length= 14065] IHC S-500: weight [ram=25, hammer with ram in air= 55]; dimensions [outer diam. hammer= 1220, hammer length= 10200]
Maximum Operating Energy Level of the Hammer	IHC S-1200: max blow energy on pile [1200]; min blow energy on pile [60]; blow rate at max energy [30] IHC S-500: max blow energy on pile [500]; min blow energy on pile [20]; blow rate at max energy [45]
Driving Rate	2 to 36 impacts per minute
Source Level of the Noise (dB re 1 µPa at 1 meter)	232 dB re 1 µPa at 1 m (rms, 1/8-second) calculated from measurement of 182 dB re 1 µPa at 320 m (rms, 1/8-second) at Utgrunden Wind Park, Sweden. a/
Spectral Energy of the Noise (center frequency and total range)	1 Hz to 20 kHz
Noise Propagation Modeling	178 dB re 1 µPa at 500 m (rms, 1/8-second) 172 dB re 1 µPa at 1 km (rms, 1/8-second) 166 dB re 1 µPa at 2 km (rms, 1/8-second)

a/ Ødegaard & Danneskiold-Samsøe A/S, "Offshore Wind-Turbine Construction, Offshore Pile-Driving Underwater and Above-Water Noise Measurements and Analysis," Report No. 00.877, Copenhagen, Denmark, October 2000.

Vessels

Maximum whale hearing thresholds for vessels were calculated for a distance of 100 ft (30.5 m). Increases over hearing thresholds of 42 dB and 45 dB were calculated for whales and for toothed whales, respectively. These levels are well below the injury threshold of 130 dB and the harassment threshold of 90 dB. The animal would be able to hear the vessel, but no physical harm would be expected to occur as a result of noise. Although behavioral impacts are possible (i.e., a whale changing course to move away from a vessel), the number and frequency of vessels present associated with the proposed action is small and any behavioral impacts would be expected to be minor.

The jet plow embedment process for laying the two submarine cable circuits and inner-array cables produces no sound beyond that produced by typical vessel traffic and the cable installation barge will produce sound typical of vessel traffic already occurring in Nantucket Sound. Furthermore, no substantial underwater sound will be generated during horizontal directional drilling.

Any whales are likely to temporarily avoid a given area around the construction, and only minor impacts would be anticipated due to the proposed action's construction generated noises. Any noise should not affect the migration, nursing/breeding, feeding/sheltering or communication of whales. In addition, given the probable infrequency of listed whales occurring in the proposed action area, impacts to listed whales are expected to be minor.

Wind Turbine Operational Noise

Once installed, the operation of the WTGs is not expected to generate substantial sound levels above baseline sound in the area. Preliminary results from noise studies conducted in the United Kingdom suggest that in general, the level of noise created during the operation of offshore windfarms is very low and does not cause avoidance of the area by marine species (Nedwell, unpub. data). Even in the area directly surrounding the wind turbines, noise was not generally found above the level of background noise, resulting in normal activity of marine animals (Nedwell, unpub. data).

Acoustic modeling of underwater operational sound at the Wind Park was performed for the design wind condition (see Section 3.13 of ESS, 2007). Baseline underwater sound levels under the design wind condition are 107.2 dB. The predicted sound level from operation of a WTG is 109.1 dB at 65.6 ft (20 m) from the monopile (i.e., only 1.9 dB above the baseline sound level), and this total sound level falls off to 107.5 dB at 164 ft (50 m) and declines to the baseline level at a relatively short distance of 361 ft (110 m)). Since the WTGs will be spaced farther apart than 360 ft (110 m) (approximately 629 to 1,000 m or 0.34 to 0.54 nautical miles apart), no cumulative impacts from the operation of the 130 WTGs in the Wind Park are anticipated.

An analysis of predicted underwater sound levels perceived by whales from the proposed action's operation show that no injury or harassment to whales are predicted even if an individual were to approach as close as 65.6 ft (20 m) to a monopile when the proposed action is operating at the design wind speed as all increases over hearing thresholds at this minimum distance are well below 90 dB. In fact, the proposed action operation will be inaudible for toothed whales, and only slightly audible to baleen whales at the extremely close distance of 65.6 ft (20 m). Therefore, no behavioral effects to whales are anticipated even if an individual were to approach within 65.6 ft (20 m) of the structures.

Decommissioning Noise

Noise produced by the decommissioning of the proposed action is expected to be similar to those produced during the proposed action's construction. The proposed action's decommissioning will not require pile driving activities, which cause the highest sound levels of any activities associated with the proposed action. Pile driving only takes place during the construction phase of the proposed action. Decommissioning will involve the use of similar vessels, cranes, jet plow, cutting and welding equipment and other tools that were involved in construction, but would not include any pile driving, blasting or activities which approach the noise level of pile driving. During decommissioning, the monopiles and transition pieces would be cut off at the mudline. As such, the noise impacts from decommissioning activities would appear to be less than the worst case impacts already presented for construction and will be minor. However, consultations with other Federal agencies will be conducted in order to confirm the potential for impact.

5.1.1.2 Vessel Traffic

Vessel Strikes

Vessel strikes to listed cetaceans can result in injury or death of the animal. The potential risk to listed whale species from collisions with proposed action-vessels is evaluated below.

Ship collisions are a significant threat to large cetaceans and is considered the single important source of human-caused mortality in some species (Jensen and Silber, 2003; Waring *et al.,* 2006). While ship strikes occur throughout the world, several studies document that the greatest number of incidents occur within the North American east coast (Laist *et al.,* 2001; Jensen and Silber, 2003; Waring *et al.,* 2006). Along the North American east coast there is a high concentration of large cetaceans and a significant volume of vessel traffic, enabling a greater chance of a collision but also the greater likelihood of reporting of any strikes possibly biasing any assumptions (Jensen and Silber, 2003).

The majority of vessels that have documented whale strikes are large, fast moving vessels such as container ships, tankers or military vessels (Jensen and Silber, 2003). There are several documented collisions of cetaceans with smaller vessels (less than 65 ft [19.8 m]); however all of these collisions were with boats traveling at higher speeds (Right Whale News, 2005). Collisions with vessels that are moving at slower speeds (less than 14 knots [7.2 m/s]), such as the construction vessels to be used for the proposed action, are less likely, and there have been no recorded ship strikes from vessels traveling less than 10 knots (5.1 m/s) (Laist *et al.,* 2001).

Humpback, right and fin whales should be able to detect any tugboat, barge and other slow-moving vessels within the area of the proposed action, as baleen whales can easily detect and respond to sounds of the frequency range and intensity of those produced by tugboats and barges (Miles *et al.,* 1987; Richardson *et al.,* 1991; McCauly, 1994). Humpback whales are relatively tolerant of boats, but, due to this habituation they may be more susceptible to ship collisions. Whale response, however, are unpredictable and may depend on the activity of the whale at the time, or its previous experience with other motor vehicles.

Despite the expected ability of right whales to hear approaching vessels, they continue to die from vessel collisions (Richardson *et al.,* 1995; Nowacek *et al.,* 2004). A study by Nowacek *et al.*, (2004), reported that right whales did not respond to the sounds of approaching vessels or the actual vessels. Some anecdotal observations suggest that right whales only respond when vessels approach to within a very close range. Right whales off the eastern coast of North America are frequently exposed to vessels, and they may have habituated to the sounds of approaching vessels at great distances (Richardson *et al.,* 1995; Terhune and Verboom, 1999; Laist *et al.,* 2001).

Although vessel collisions are a primary cause of large whale mortality in the western North Atlantic, the Project is not expected to put whales at increased risk for vessel collisions. As stated earlier, vessels moving at slower speeds (less than 14 knots), such as the construction vessels to be used for the Project, are less likely to cause collisions (Laist *et. al.*, 2001). In addition, the vessel routes proposed to be used by Project vessels do not occur in areas where there have been high concentrations of whale sightings.

Vessel Harassment

Any impact on marine species due to the physical presence of the proposed action-vessels is expected to be minor. There have been many studies of the effects of vessels on cetaceans, particularly the underwater noises they make (Richardson *et al.,* 1985, 1991). It is likely that whales and dolphins react primarily to the sound generated by vessels, and not their physical presence (NMFS, 2001; NMFS, 2002). Moreover, the central portion of Nantucket Sound and the vessel routes proposed to be used by the proposed action vessels are not within what is considered a high use area for listed whale species. If any MMPA protected animals are present in the area of the proposed action, potential behavior changes in response to proposed action-related vessel traffic would be short-term and would likely be similar to the behaviors observed during regularly occurring activities in Nantucket Sound such as the personal boat use, whale watching cruises, ferry traffic and fishing. Close encounters between proposed action vessels and species are likely to be rare and result in minimal physical disturbance to the animals.

The effects of vessel harassment on the migration, breeding and feeding behaviors of cetaceans are expected to be minor. Based on the undeveloped source of whale prey in Nantucket Sound, it is highly unlikely that cetaceans would be migrating through, nursing or feeding in Nantucket Sound, but further offshore. The physical presence of vessels associated with proposed action construction would not contribute to the harassment of migrating, nursing or feeding humpback, fin or right whales. These large migratory whales are only expected to be within the vicinity of New England waters during the spring and summer feeding seasons. However, preferred whale prey is not found abundantly within Nantucket Sound, rather most feeding grounds for these species are further offshore and would not be directly impacted by proposed action construction. Some seasonal residents of Nantucket Sound, such as harbor porpoises, may experience some displacement from traditional feeding grounds, however this should be temporary and most species found within the vicinity of the proposed action are habituated to high volumes of vessel traffic.

As mentioned previously, vessel strikes have caused mortality in cetaceans in New England waters (Waring *et al.,* 2006). During decommissioning activities, as during construction activities, it is estimated that 4 to 6 stationary or slow moving vessels would be present in the general vicinity of the pile removal. Vessels delivering demolition materials or crews to the site would also be present in the area between the mainland and the site of the proposed action. The barges, tugs and vessels carrying materials would be limited to speeds below 10 knots (5.1 m/s) and may range in size from 90 to 400 ft (27.4 to 122 m), while the vessels carrying crews would be traveling at a maximum speed of 21 knots (10.8 m/s) and would typically be 50 ft (15.2 m) in length. The vessels used for the decommissioning of the proposed action would be smaller, slower moving vessels than those that regularly cruise Nantucket Sound, with expected impacts on cetacean populations in Nantucket Sound to be minor.

Humpback whales are relatively tolerant of boats, but, due to this habituation, may be more susceptible to ship collisions. Right whales continue to die from vessel collisions, even though they can theoretically hear approaching ships (Richardson *et al.,* 1995; Nowacek *et al*., 2004). A study by Nowacek *et al*. (2004), reported that right whales did not respond to the sounds of approaching vessels or the actual vessels. Some anecdotal observations suggest that right whales only respond when vessels approach to within a very close range. Right whales off the eastern coast of North America are frequently exposed to vessels, and they may have habituated to the sounds of approaching vessels at greater distances (Richardson *et al*., 1995; Terhune & Verboom, 1999; Laist *et al*., 2001). The greatest known current cause of right whale mortality in the western North Atlantic is collision with large ships such as container ships, military vessels and tankers. There were 27 documented deaths from 1970 through 1991 (NMFS, 2005). From 1991 through the beginning of 1993, an additional 3 deaths were reported as a result of collisions with vessels (NMFS, 2005). According to a recently published large whale ship strike database based on public information collected by NOAA Fisheries from 1975 to 2002 (Jensen and Silber, 2003), finback whales are the most often reported species hit by ships (75 records of strike) followed by humpback (44 records), North Atlantic right (38 records), gray (24 records), minke (19 records), southern right (15 records), and sperm whales (17 records).

As discussed above in the species descriptions for humpback, fin, and right whales, respectively, each of these species are known to seasonally migrate between their fall/winter mating, birthing, and nursing grounds in the southern waters of the West Indies and the mid- and south-Atlantic states (including the Carolinas, Georgia, and Florida), and their spring/summer feeding grounds in the western North Atlantic (Clapham, 1992; Baraff and Weinrich, 1993; Waring *et al*., 2006; NMFS, 2005; CeTAP, 1982; USEPA Region 1, 1988). Therefore, whales are only expected to be within the vicinity of New England waters during the spring and summer feeding seasons. While the endpoints of the whales' migration are well established (Martin *et al.,* 1984; Mattila *et al.,* 1989; Waring *et al*., 2006), the exact route between the summer and wintering grounds is unknown, although it is likely to be well offshore (Clapham and Mattila, 1990).

Once the north-bound migrating whales (cow-calf pairs included) reach their feeding grounds in New England waters, as discussed above, their fine-scale movements have generally been observed to follow dense aggregations of their preferred prey species, which are not developed in Nantucket Sound, and tend to occur in greater abundance in waters further offshore, around Stellwagen Bank, Jeffreys Ledge, Browns and Bacaro Banks, and in the Great South Channel (Kenney and Winn 1986). Additionally, both feeding and nursing behaviors have been observed in Cape Cod Bay and the lower Bay of Fundy (Schevill *et al.,* 1986; Hamilton and Mayo, 1990; Marx and Mayo, 1992; Kraus and Kenney, 1991; NMFS, 1994; NMFS, 2005; Waring *et al*., 2006).

It has been reported that vessel traffic also may physically displace some whale species from feeding areas. There is evidence that some whales may have been displaced from traditional feeding and wintering areas due to increased vessel traffic in Pacific waters (Baker *et al*., 1982; Forestell, 1986). Hawaiian research of Pacific humpback populations have observed cow-calf pairs to move away from areas presumed to be favored habitat where human activities were also common (Lien, 2005). Canadian research regarding humpbacks' response to whale watching activities also observed cow-calf pairs to be especially sensitive to human presence (Lien, 2005). However, evidence from whale watching and fishing activities in Massachusetts waters indicates that humpback and fin whales readily habituate to the presence of large and small motor vessels (Watkins, 1986).

Based upon the underdevelopment of whale prey species in Nantucket Sound, it is highly unlikely that whales would be migrating through, nursing, or feeding in Nantucket Sound. Therefore, the physical presence of vessels associated with the construction, operation, and decommissioning of the proposed wind farm in Nantucket Sound will not contribute to the harassment of migrating, nursing, or feeding humpback, fin or right whales.

5.1.1.3 Water Quality

Increased TSS

The primary water quality concern to the listed species addressed in this BA is elevated concentrations of Total Suspended Solids (TSS) associated with construction and decommissioning of the proposed action. Sustained elevated concentrations of TSS may deter the protected species (direct impact) and may potentially affect prey species (indirect impact) of whales (i.e., zooplankton and fish). However, as indicated below, construction and decommissioning activities are expected to result in only temporary and localized increases in TSS and therefore will have minimal impacts to the listed species.

Construction activities associated with installing the monopile foundations, scour control, and submarine cables will result in a temporary and localized increase in suspended sediment concentrations. Decommissioning-related impacts will be short-term and localized and are expected to be similar to impacts during construction. The pile driving hammer and jet plow technology that will be used to install the monopile foundations and the submarine cables, respectively, were selected specifically for their ability to keep sediment disturbance to a minimum. Due to the predominant presence of fine to coarse-grained sands in Nantucket Sound, localized turbidity associated with the proposed action's construction or decommissioning is anticipated to be minimal and confined to the area immediately surrounding the monopiles and the submarine cable route. Sediments disturbed by construction or decommissioning activities are expected to settle back to the sea floor within a short period of time (one to two tidal cycles). In addition, the Area of the proposed action is situated in a dynamic environment that is subject to naturally high suspended sediment concentrations in near-bottom waters as a result of relatively strong tidal currents and wind and storm generated waves, particularly in shoals areas. Therefore, marine organisms in this area are accustomed to substantial amounts of suspended sediment on an irregular basis and should not be substantially impacted by a temporary increase in turbidity from the proposed action's activities.

Simulations of sediment transport and deposition from jet plow embedment of the submarine cable system and the inner-array cables were performed. These simulations, which used two models (HYDROMAP to calculate currents and SSFATE to calculate suspended sediments in the water column and bottom deposition from the jet plow operations), estimated the suspended sediment concentrations and deposition that could result from jet plow embedment of the cables. The full analysis is included in Report No. 4.1.1-2.

The model results demonstrate that concentrations of suspended sediment in the water column resulting from jet plow embedment operations (i.e., concentrations above natural background conditions) are largely below 50 mg/L. The effect of grain size distribution is evident since the finer sediments present in portions of the Lewis Bay area, the area at the southern half of the north-south portion of the route, and the area just northwest of the ESP remain in suspension longer due to higher silt and clay fraction. This results in larger predicted plume extents.

It is important to note that the suspended sediment concentration levels are short lived due to the tides flushing the plume away from the jetting equipment and the sediments rapidly settling out of the water column. To put the water column concentrations in perspective, Figure 4.5 of Report 4.1.1-2 shows the duration that a 10 mg/L excess (above background) suspended sediment concentration is seen. Most of the area shows a duration of less than 3 hours after the jet plow has passed a given point along the route. In places along and immediately adjacent to the cable route, suspended sediment concentrations are predicted to remain at 100 mg/L for approximately 2 to 3 hours.

In Lewis Bay, suspended sediments are predicted to remain in suspension considerably longer than in Nantucket Sound due to weak tidal currents. As a result, water column concentrations are predicted to build-up rather than quickly disperse. The model results demonstrate that concentrations of suspended sediment in the water column resulting from jet plow embedment operations (i.e., concentrations above natural background conditions) in Lewis Bay are largely below 500 mg/L. Suspended sediment concentrations in excess of 100 mg/L are generally predicted to remain for less than 2 hours with the exception of some sections along the cable route showing durations at 6 hours. Suspended sediment concentrations in excess of 10 mg/L are generally predicted to remain for less than 24 hours after the jet plow has passed a given point along the route, except near the Yarmouth landfall where concentrations in excess of

10 mg/L are predicted to remain for up to 2 days after the jet plow passes as a result of very weak currents and fine bottom sediments.

These TSS concentrations are still minimal when compared to the active bed load sediment transport known to exist in Nantucket Sound (between 45 and 71 mg/L under natural tidal conditions and up to 1,500 mg/L as a result of trawling operations (see Section 3.16.2.2 of ESS, 2007). Sediment suspension during construction and decommissioning activities will not result in long-term or environmentally significant elevations in water column TSS. Zooplankton or fish species may be temporarily affected or displaced in the immediate vicinity of the area of the activity; however, they are likely to rapidly return to these areas once construction in the specific area is ceased or completed. In addition, since the area of the proposed action is situated in a dynamic environment that is subject to naturally high suspended sediment concentrations in near-bottom waters, these organisms would be accustomed to substantial amounts of suspended sediment on an irregular basis and should not be substantially impacted by a temporary increase in turbidity from the proposed action's activities. Whales and sea turtles that may be present in the vicinity of the area of the proposed action during construction are not expected to be adversely affected by temporary increases in TSS and since they are mobile, are capable of avoiding or moving away from the disturbances associated with construction.

Sediment suspension during excavation of the HDD borehole ends in Lewis Bay will be minimal since these activities will be contained within the cofferdam and the top of the sheet piles for the cofferdam will contain turbidity associated with dredging for the HDD borehole end transition. Furthermore, it is unlikely that the protected whale or sea turtle species would be present this close to shore in Lewis Bay. Therefore, no impacts to these protected marine species will occur from the limited, contained sediment suspension during excavation of the HDD borehole ends in Lewis Bay. These activities will not be required during decommissioning.

Protected whales are not likely to occur within the proposed action area in Nantucket Sound; however, any random individuals that may pass through the area would be exposed to substantial amounts of suspended sediment on a regular basis from natural events such as storms and strong tidal currents, and a temporary increase in turbidity from proposed action's activities would have minor impacts.

Contaminated Sediments

Whales bioaccumulate contaminants from their ocean environment, almost exclusively through their food sources. The potential mechanism by which sediments suspended during the proposed action's construction can harm whales is through bioaccumulation of sediment-associated chemicals through ingestion of contaminated prey (indirectly).

Analysis of sediment core samples obtained from the area of the proposed action indicate that sediment contaminant levels were below established thresholds in reference Effect Range-Low (ER-L) and Effects-Range-Median (ER-M) marine sediment quality guidelines (Long *et al.*, 1995). Therefore the temporary and localized disturbance and suspension of these sediments during the proposed action's construction activities are not anticipated to result in increased contaminants in lower trophic levels. Therefore, whales are unlikely to experience increased bioaccumulation of chemical contaminants in their tissues from the consumption of prey items in the vicinity of the proposed action, and any impacts are expected to be minor (See Section Table 3.2 of Report 4.1.1-1 for a complete analysis of the sediment core samples).

During the nearshore installation, the release of contaminants from the Horizontal Direction Drilling (HDD) operation within Lewis Bay will be minimized through a drilling fluid fracture or overburden breakout monitoring program, minimizing the potential of drilling fluid breakout into the water. The drilling fluid will consist of water (approximately 95 percent) and an inorganic, bentonite clay (approximately 5 percent). The bentonite clay is a naturally occurring hydrated aluminosilicate composed of sodium, calcium, magnesium, and iron. In the unlikely event of drilling fuel release, the bentonite fluid density and composition will cause it to remain as a cohesive mass on the seafloor in a localized slurry pile similar to the consistency of gelatin. This cohesive mass can be quickly cleaned up and removed by divers and appropriate diver-operated vacuum equipment; thereby minimizing any long-term impacts to protected whales.

Decommissioning-related impacts will be short-term and localized and are expected to be similar to or less than impacts during construction. The suspension of solids are expected to be temporary and localized, as the removal technology that will be used to install the monopile foundations and the submarine cables, respectively, were selected specifically for their ability to keep sediment disturbance to a minimum. Further, the physical composition of the sands and the physical characteristics of the sound environment provide reason to believe that any localized turbidity will settle back to the sea floor within a short period of time (one to two tidal cycles).

5.1.1.4 Reduced Habitat

Activities related to proposed action's construction may cause whales to avoid habitat areas in the vicinity of the proposed action. The main anticipated impact would be avoidance of areas where pile driving is occurring or where project-related vessels may be present. However, the increase in vessel traffic associated with the project is minimal and is not anticipated to displace whales for long periods of time. Some avoidance may also occur during construction activities due to acoustical harassment (i.e., from pile driving), as mentioned previously, however this disturbance will be temporary and will not result in any major effects on the listed whales. Studies at off-shore Danish Wind Farms showed that harbor porpoises temporarily avoided the area in the vicinity of the turbines only during construction, and mainly during pile driving activities (Danish Offshore Wind – Key Environmental Impacts, 2006). Abundances for harbor porpoises slowly returned to close to pre-construction values for most of the area, with only a limited area with strong negative impacts mainly detected as permanent avoidance of that specific area. Although effects are expected to be temporary, there is the potential for whales to permanently avoid portions of the proposed action area. However, given the probable infrequency of listed whales occurring in the vicinity of Horseshoe Shoals, overall impacts are expected to be minor and mainly temporary.

Activities under the proposed action are only anticipated to result in minor changes in whale prey abundance or distribution. Some temporary displacement may occur during periods of noise or high suspended sediments, but this will be limited to areas directly surrounding the given activities, causing both prey species and whales to move to an undisturbed area. Pelagic prey tends to be highly variable and animals foraging on these sources move with the food source, as seen with many whales and their prey species. Any temporary disturbance to pelagic prey is likely to mimic typical temporal and spatial variability, and is likely available in other areas of Nantucket Sound and surrounding waters for foraging by whales. However, as stated previously, based on the underdevelopment of whale prey species in Nantucket Sound, it is highly unlikely that whales would be feeding in the proposed action area.

5.1.1.5 Habitat Shift

The presence of 130 monopile foundations, 6 ESP piles and their associated scour control mats in Nantucket Sound has the potential to shift the area immediately surrounding each monopile from soft sediment, open water habitat system to a structure-oriented system, with minor effects to whales. The listed whale species are not anticipated to be attracted to the WTGs for feeding purposes. All three listed whale species occur only rarely in Nantucket Sound and therefore are not expected to be influenced by potential finfish or benthic organism aggregations at the individual WTG monopiles. Their primary feeding grounds are located further offshore from Nantucket Sound at Stellwagen Bank, in Cape Cod Bay, and in the Gulf of Maine. In addition, none of the listed whale species would be attracted to the WTGs as potential shelter.

At the end of the proposed action's lifespan, removal of the WTG monopile foundations and ESP piles at the time of decommissioning would result in a localized shift from a structure-oriented habitat near the WTGs and ESP to the original shoal-oriented habitat present prior to construction of the proposed action. However, as the addition of the monopiles would be a minor addition to the hard substrate that was present prior to the construction of the Wind Park, the removal of the WTGs and ESPs will not cause a great impact in the overall habitat structure. As described above, the listed whale species are not anticipated to be attracted to the WTGs for feeding purposes or as potential shelter. Therefore, removal of the WTGs and ESPs will not affect whale feeding or distribution.

5.1.1.6 EMF

Potential direct or indirect impacts to listed whales during the normal operation of the inner-array cables and the two submarine cable circuits are expected to be discountable or insignificant. The cable system (for both the inner-array cables and each of the submarine cable circuits) is a three-core solid dielectric AC cable design, which was specifically chosen for its minimization of environmental impacts and its reduction of any electromagnetic field. The proposed inner-array and submarine cable systems for the proposed action will contain grounded metallic shielding that effectively blocks any electric field generated by the operating cabling system. Since the electric field will be completely contained within those shields, impacts are limited to those related to the magnetic field emitted from the submarine cable system and inner-array cables. As presented in Report No. 5.3.2-3, the magnetic fields associated with the operation of the inner-array cables or the submarine cable system are not anticipated to result in an adverse impact to marine mammals, or their prey (ICNIRP, 2000; Adair, 1994; Valberg *et al.*, 1997).

The research presented in the technical report on EMF indicates that although high sensitivity has been demonstrated by certain species (especially sharks) for weak electric fields, this sensitivity is limited to steady (DC) and slowly-varying (near-DC) fields. The proposed action produces 60-Hz time-varying fields and no steady or slowly-varying fields. Likewise, evidence exists for marine organisms utilizing the geomagnetic field for orientation, but again, these responses are limited to steady (DC) and slowly-varying (near-DC) fields. 60-Hz alternating power-line EMF fields such as those generated by the proposed action have not been reported to disrupt marine organism behavior, orientation, or migration. Based on the body of scientific literature examined, there are no anticipated adverse impacts expected from the undersea power-transmission cables or other components of the proposed action on the behavior, orientation, or navigation of marine organisms, including listed whale species (Report No. 5.3.2-3).

5.1.1.7 Proposed Action Impact Analysis- Routine Conditions

The major impact-producing factors affecting whales as a result of the proposed action's activities include noise generated by construction and operational activities; vessel traffic; temporary reduced habitat; and degradation of water quality.

The main underwater acoustical impacts during construction activities will be limited to that generated by installation of the monopile foundations and vessel traffic.

Although vessel collisions are a primary cause of large whale mortality in the western North Atlantic, the proposed action is not expected to put whales at increased risk for vessel collisions. Vessels moving at slower speeds (less than 14 knots [26 km/h]), such as the construction vessels to be used for the proposed action, are less likely to cause collisions (Laist *et al*., 2001). In addition, the vessel routes proposed to be used by the proposed action vessels do not occur in areas where there have been high concentrations of whale sightings. Based upon the underdevelopment of whale prey species in Nantucket Sound, it is highly unlikely that whales would be migrating through, nursing, or feeding in Nantucket Sound. Therefore, the physical presence of vessels associated with the construction, operation, and decommissioning of the proposed wind farm in Nantucket Sound will not contribute to the harassment of migrating, nursing, or feeding humpback, fin, or right whales. Any impact will be limited to temporary avoidance of an area; however this is unexpected due to the high volumes of vessel traffic that normally travel the waters of Nantucket Sound. Therefore, the impacts of increased vessel traffic should have minor impacts on listed whales.

It is possible, yet difficult to predict, whether there will be increased fishing activity after the Wind Park is operational. Such fishing efforts will mainly be by private and recreational charter boats using hook and line fishing gear, which should not adversely impact any whale or dolphin species.

The proposed action construction and decommissioning are not anticipated to result in changes in whale prey abundance or distribution. Some temporary displacement may occur during periods of noise or high suspended sediments, but this will be limited to areas directly surrounding the given activities, causing both prey species and whales to move to an undisturbed area. Pelagic prey tends to be highly variable and animals foraging on these sources move with the food source, as seen with many whales and their prey species. Any temporary disturbance to pelagic prey is likely to mimic typical temporal and spatial variability, and is likely available in other areas of Nantucket Sound and surrounding waters for foraging by whales. The proposed action construction is therefore anticipated to have minor impacts on whales in regards to reduced habitat and prey availability. However, as stated previously, based on the underdevelopment of whale prey species in Nantucket Sound, it is highly unlikely that whales would be feeding in the proposed action area.

As discussed previously in the proposed action construction impacts, there is little potential for whales to bioaccumulate chemical contaminants in their tissue from consuming prey within the area of the proposed action. The suspension of the sediments due to the proposed action's decommissioning activities is not anticipated to increase the amount of contaminants found within lower trophic levels.

5.1.1.8 Summary and Conclusion – Routine Activities

Routine activities associated with the proposed action will have minor impacts on the whale species that may be found in the proposed action area. Temporary avoidance is mainly anticipated during periods of construction or vessel operation noise. Permanent avoidance of the area post-construction may occur simply due to the presence of the WTGs and operation of the proposed action. However, given the probable infrequency of listed whales occurring in the proposed action area, impacts on listed whales from routine events under the proposed action are expected to be minor.

5.1.2 Whales-Non-routine or Accidental Events

Accidental and unexpected events associated with the proposed action could impact whales. Such impacts would primarily be the result of oil spills, but may also relate to cable repair, collapse of a monopile, vessel collision, and geotechnical and geophysical investigations.

5.1.2.1 Oil Spills

Oil spills could occur either as a release from the ESP storage tank or from a vessel collision with a monopile. Little species-specific information is available regarding the effects of oil spills on whales. Past studies suggest that large whale species do not seem to be particularly sensitive to oil spills. A study of fin whales found the whales swimming in an oil slick on Nantucket Shoals following the spill of almost eight million gallons of fuel oil. None of the whales observed showed any obvious signs of distress in the short term (Grose and Mattson, 1977). Another study reported fin whales surfacing in heavy slicks following a spill of fuel oil southeast of Cape Cod with no apparent adverse impacts (Goodale *et al*., 1981).

Because they rely on blubber for insulation, whales are less vulnerable to oil spills than fur-coated marine mammals which can die from hypothermia when coated in oil. In addition, humpback whales, fin whales and right whales are all migratory which may limit their exposure to a persistent oil slick in a small geographic area. Of the three listed whale species, the right whale population should be considered at greatest risk to being negatively impacted by an oil spill because of the small population size and slow recovery of their numbers from earlier depletion from whaling. Pollution from various anthropogenic sources has been suggested as one possible cause of the slow right whale recovery. The right whale population may be more vulnerable to long-term oil spill effects than humpback and fin whales whose larger numbers provide greater resiliency to their populations.

Although most research suggests that whales do not appear to be especially sensitive to spills, other studies have shown that there are negative long-term effects to whales from exposure to oil. Direct mortality as a result of contact with oil and development of brain lesions were reported after the Exxon Valdez Spill in Alaska. When surfacing, oil may irritate whale's eyes and skin and they may breathe in harmful fumes. Other symptoms of acute exposure to oil include lethargy, poor coordination and difficulty breathing which can lead to drowning (Hammond *et al*., 2001). However, the case of the Exxon Valdez should be considered an extreme example which represented a spill much larger than any worst-case scenario from Cape Wind.

Oil spills have the potential to also affect whale prey sources. However, given the probable infrequency of listed whales occurring in the proposed action area, that this proposed action area is not known as a right, fin or humpback whale feeding area, and that there is a low probability of a large oil spill, the potential adverse affects from an oil spill event is considered discountable or insignificant.

5.1.2.2 Cable Repair

Many of the types of disturbances that would occur during cable repair activities are smaller and shorter duration, but of similar type, to those that would occur during cable installation. A relatively short distance along the sea floor would be disturbed by the jetting process used to uncover the cable and allow it to be cut so that the ends could be retrieved to the surface. In addition to the temporary loss of some benthic organisms, there would be increased turbidity for a short period, and a localized increase in disturbance due to vessel activity, including noise and anchor cable placement and retrieval. Given the small area, short duration, and infrequency of occurrence of listed whales in the area of the proposed action, potential adverse impacts from cable repair activities on the listed whales would be discountable or insignificant.

5.1.2.3 Vessel Collision with Monopile

The extent of potential impacts that could result from a vessel collision with a monopile largely depends on the extent of damage to the monopile or vessel, as well as the nature of the vessel. Some smaller vessels would merely strike a glancing blow and suffer some hull damage but not sink. Other vessels may suffer enough damage to sink, causing a small release of fuel and debris. A larger vessel, such as an oil tanker, would most likely cause a collapse of the monopile, also resulting in a small release of lubricating fluid. If oil being transported were to be released, then depending upon the quantity released, an oil spill that escapes Nantucket Sound could directly affect listed whales (see section 5.1.2.1). Repair of a damaged or collapsed monopile would create short term and localized disturbances to the benthos, water column, and pelagic organisms similar to the construction and decommissioning of a single monopile, albeit in reverse order and combined in a single event. Since these disturbances are localized to the monopile they are unlikely to adversely affect listed whale species, and therefore potential adverse impacts resulting from a vessel collision with a monopile and the associated repair activities on the listed whales would be discountable or insignificant.

5.1.2.4 Geotechnical and Geophysical Investigations

Many of the types of disturbances that would occur during the geotechnical and geophysical investigations are short term and very localized. A very small area of the sea floor would be disturbed by coring activities, either at the core hole or associated with the coring vessel anchor placements. It is likely that the duration of activity at any one coring location would be no more than a few days. The high resolution geophysical survey work, including collection of shallow (Chirp) and intermediate depth (Boomer) subbottom profiler data and sidescan sonar and magnetometer data, uses mobile gear towed behind a vessel, and would not result in bottom disturbance, nor does it result in activity at a fixed location. The geotechnical investigations would result in a negligible temporary loss of some benthic organisms, and a localized increase in disturbance due to vessel activity, including noise and anchor cable placement and retrieval. Given the small area of disturbance, short duration of activities, and infrequency of occurrence of listed whales in the area of the proposed action, potential adverse impacts from geotechnical and geophysical investigations to the listed whales would be minor (Additional details on geotechnical and geophysical field investigations are presented in Section 2.7 of the DEIS).

5.1.2.5 Proposed Action Analysis-Non-Routine or Accidental Scenarios

Given the probable infrequency of listed whales occurring in the proposed action area, that this proposed action area is not known as a right, fin or humpback whale feeding area, and that there is a low probability of a large oil spill; the potential adverse affects from an oil spill event is considered discountable or insignificant. The other potential non-routine or accidental events that have been evaluated all have very localized and short term affects on the habitat, and when combined with the low probability of a listed whale species occurring in the area of the proposed action when one of these activities is occurring, the potential impacts to listed whales is minor.

5.1.2.6 Summary and Conclusion – Non-routine Conditions

Non-routine or accidental activities associated with the proposed action will have discountable or insignificant to minor impacts on the listed whale species that may be found in the proposed action area. Either the activity is so short term or localized, or is unlikely to occur, that alteration of habitat or direct affects on listed whale species are unlikely to occur, or if they do occur, would have essentially little to no adverse affects.

5.2 Sea Turtles

5.2.1 Sea Turtle- Routine Activities

The major impact-producing factors affecting sea turtles as a result of proposed action include noise associated with construction and operation activities, vessel traffic, changes in water quality and the establishment of "fouling" communities on monopiles.

5.2.1.1 Construction and Operational Noise

Little published data were available regarding the hearing threshold for sea turtles. Unpublished data from the Office of Naval Research regarding a hearing threshold study being done at New England Aquarium on Green Turtles were obtained and combined with other available information in order to develop a hearing threshold for sea turtles. The hearing bandwidth is relatively narrow, ranging from 50 to 1,000 Hz, with a maximum sensitivity at around 200 Hz. The hearing threshold is very high, over 100 dB in the low frequencies where construction noise occurs.

Pile Driving

A dB_{ht} was calculated for sea turtles to determine the actual underwater sound level that is heard by sea turtles from monopile installation at different distances from construction activities. The results of the dB_{ht} analysis show that no injury to sea turtles are predicted, if an individual were to approach as close as 30 m to the pile driving because all dB_{ht} values at this minimum distance are well below 130 dB re 1 µPa. In fact, sea turtles were found to be the least sensitive to noise of all the species evaluated.

In addition to pile driving noise, the post lease G&G investigation would result in noise associated with vibracores and drilling of bore holes to acquire subsurface geological information on the sea bottom. The vibracores would be accomplished via a small gasoline motor and the drilling of cores would be accomplished via a truck mounted drill rig on a barge. Both of these activities would be very short term, and these devices generate sound levels that are much lower than sound levels associated with pile driving. Sound levels from a small gasoline motor would be comparable to that associated with a small motorized boat. Sound levels from a truck mounted drill rig would be comparable to those on a small ship or large boat. These types of sounds occur regularly in the area. Thus noise impacts on sea turtle species are expected to be discountable or insignificant with respect to G&G activity.

Vessels

A maximum sea turtle hearing thresholds for vessels was calculated for a distance of 100 ft (30.5 m). A level of only 17 dB_{ht} was calculated, well below the injury threshold of 130 dB_{ht} and the harassment threshold of 90 dB_{ht}. The animal would be able to hear the vessel, but no physical harm or behavioral effects would occur.

The jet plow embedment process for laying the offshore transmission cable system circuits and inner-array cables produces no sound beyond that produced by typical vessel traffic and the cable installation barge would produce sound typical of vessel traffic already occurring in Nantucket Sound. Furthermore, no substantial underwater sound would be generated during HDD.

Any sea turtles are likely to temporarily avoid a given area around the construction, and, given the known areas that the sea turtles inhabit within Nantucket Sound, only minor impacts would be anticipated due to proposed action construction generated noises. Any noise should not affect the migration, nursing/breeding, feeding/sheltering, or communication of sea turtles.

Wind Turbine Operational Noise

Once installed, the operation of the WTGs is not expected to generate substantial sound levels above baseline sound in the area. Existing underwater sound levels for the design condition are 107.2 dB. The calculated sound level from operation of a WTG is 109.1 dB at 65.6 ft (20 m) from the monopile (i.e., only 1.9 dB above the baseline sound level), and this total falls off to 107.5 dB at 164 ft (50 m) and declines to the baseline level at a relatively short distance of 360 ft (110 m).

An analysis of predicted underwater sound levels perceived by sea turtles from the proposed action's operation show that no injury or harassment to sea turtles are predicted even if an individual were to approach as close as 65.6 ft (20 m) to a monopile when the Project is operating at the design wind speed as all increases over hearing threshold at this minimum distance are well below 90 dB. In fact, the proposed action's operation will be inaudible for sea turtles. Therefore, no behavioral effects to sea turtles are anticipated even if an individual were to approach within 65.6 ft (20 m) of the structures. The proposed action's operations will result in discountable or insignificant impacts on sea turtles in Nantucket Sound.

Decommissioning Noise

Noise produced by the decommissioning of the proposed action is expected to be similar to those produced during construction. Proposed action decommissioning would not require pile driving activities, which cause the highest sound levels of any activities associated with any phase of the proposed action.

5.2.1.2 Vessel Traffic

Vessel Strike

Although sea turtles are likely to dive at the approach of a vessel, they are still at risk of boat-related injuries. Between 1987 and 1993, up to 17 percent of all stranded sea turtles on the U.S. Atlantic coast had boat-related injuries (Teas, 1994a, b). Ship strikes appear to be a significant source of mortality for sea turtles, and vessel-related injuries have increased in recent years (Teas, 1994a, b). However, vessels moving at slower speeds, such as those associated with the proposed action's construction, are less likely to cause collisions (NMFS, 2001; NMFS, 2002).

In addition, sea turtles present in Nantucket Sound are likely to be foraging and their feeding behaviors may also reduce the risk of collisions. While feeding, these turtles spend most of their time submerged. Ridleys and loggerheads can spend more than 57 minutes of each hour submerged (Thompson, 1988) and between 25 and 58 percent of their time is directly on the bottom (Standora *et al*., 1994). Feeding dives last from about four minutes to as long as two hours (Renaud and Carpenter, 1994). During these long periods of submergence, loggerhead and ridley turtles are not particularly vulnerable to collisions with barges.

It is possible that some increased fishing effort could occur after the Wind Park is operational, but that is difficult to predict. It is not likely that increased trawling activity would occur after construction of the monopile structures since the fish attracted to these structures would tend to remain fairly close to each monopile. For safety reasons and to protect their gear, trawlers would not want to deploy their gear immediately next to a monopile. Trawlers would, however be able to continue trawling in the general vicinity and between the monopiles leaving enough room to safely navigate their vessel and gear.

If there is increased fishing effort, it is more likely to consist of private and charter recreational boats. It is true that this could result in increased fishing effort and boat traffic which may increase the risk of boat collisions and/or impacts from fishing gear to sea turtles. However, recreational fishing gear is likely to consist primarily of hook and line which would likely have only minor impacts to any sea turtles in the proposed action area.

Loggerhead and Kemp's ridley sea turtles could be attracted to the monopile foundations for food (such as crabs, shellfish, sponges, sea stars and fish) and shelter. Any sea turtles that may be attracted to the area of the proposed action are likely to remain near each monopile except for the times transiting the proposed action area. While close to the monopile, they are less likely to be subject to vessel interaction since prudent vessel captains would reduce speeds when approaching a monopile. It is possible that sea turtles could be at risk of interaction with vessels while transiting from one place to the next within the area of the proposed action; however, this risk should be similar to risks that turtles face throughout Nantucket Sound.

Although vessel collisions are a significant cause of sea turtle mortality in the western North Atlantic, the Project is not expected to put sea turtles at increased risk for vessel collisions. As stated earlier, vessels moving at slower speeds (less than 14 knots), such as the construction vessels to be used for the Project, are less likely to cause collisions (Laist *et. al*., 2001).

Vessel Harassment

Similar to the migration patterns of whales, the loggerhead, Kemp's ridley, leatherback, and green turtles (as discussed above in Sections 3.2) are known to seasonally migrate between their fall/winter mating and nesting grounds, and their spring/summer feeding grounds. Typically in the late spring and summer months turtles migrate in the Gulf Stream to feed between the continental shelf and the coastlines of New England, New York, and the mid-Atlantic states (NOAA, 2005a; Epperly *et al*., 1995a,b; Keinath *et al*., 1987; Schmid, 1995; Morreale *et al*., 1989; Shoop and Kenney, 1992; Morreale and Standora, 1989; Lazell, 1980; Musick and Limpus, 1997; Goff and Lien, 1988; Prescott, 1988; Shoop *et al.,* 1981; Thompson, 1988;

Collard, 1987; Márquez, 1994). As northern water temperatures begin to drop in the fall and winter, turtles migrate to the warmer coastal waters south of the Carolinas, particularly the eastern coast of Florida, the Gulf of Mexico, and the Caribbean Sea (Thompson, 1988; Shoop and Kenney, 1992; Coles *et al*., 1994; CeTAP, 1982; Henwood and Ogren, 1987).

Loggerhead turtles nest primarily along the beaches of Florida, the Yucatan Peninsula, and the Dry Tortugas (TEWG, 1998, 2000; NMFS-SEFSC, 2001), while nearly all reproduction of the Kemp's ridley takes place along a single stretch of beach near Rancho Nuevo, Mexico (NRC, 1990). Leatherback turtles nest primarily on beaches of Florida (NRC, 1990; Meylan *et al.*, 1994), the U.S. Virgin Islands (Boulon *et al.,* 1994), and isolated beaches throughout the Caribbean (Tucker, 1990). Within the United States, green turtles nest in small numbers in the U.S. Virgin Islands, Puerto Rico, and the southern Atlantic states including the Carolinas, Georgia, and Florida, where the nesting aggregation is recognized as a regionally significant colony (USFWS, 2002).

Loggerheads and Kemp's ridleys are primarily bottom feeders, foraging in shallow coastal waters where they feed on benthic invertebrates, particularly several crab mollusk species in New England's coastal waters (Burke *et al*., 1989; Morreale and Standora, 1992, 1989; Bjorndal, 1985). During the summer, groups of dozens of young ridleys are observed frequently in the coastal waters of Vineyard Sound, Buzzards Bay, MA, and in the eastern Bays of Long Island, NY (Carr, 1967; Lazell, 1980; Morreale and Standora, 1992, 1989). During feeding, both the loggerheads and the ridleys spend approximately an hour submerged (Thompson, 1988; NMFS, 1988). Although loggerheads appear to feed primarily on the bottom, they also have been observed feeding in the pelagic zone (Ruckdeschel and Shoop, 1988), similar to the leatherback turtle, which feeds primarily on jellyfish and other gelatinous zooplankton (Eckert *et al.,* 1989; Limpus, 1984). There are numerous records of leatherback turtles in New England, and as far north as Nova Scotia and Newfoundland (Goff and Lien, 1988). Their seasonal inshore movements in New England waters have been linked to inshore movements of their prey (Lazell, 1980; Payne and Selzer, 1986).

Adult green turtles differ from the other three species in several ways. They are primarily herbivorous, and feed on shallow-growing algae and sea grasses in the protected waters of reefs, bays, inlets, lagoons, and shoal areas (USFWS, 2002; Crite, 2000). As the green turtle is largely distributed in tropical and subtropical waters worldwide, there are no known records of documented green turtle feeding grounds along the beaches of New England, or more specifically, Nantucket Sound.

Due to species-specific ranges, leatherback and Kemp's ridley turtles, rather than loggerhead and greens, are more commonly encountered in Nantucket Sound (Lazell, 1980; Shoop and Kenney, 1992; Goff and Lien, 1988; Prescott, 2000). Minimal recordings exist of the green turtle as far north as Cape Cod (Prescott, 2000); and during the summer, loggerheads are encountered more frequently in Long Island Sound, New York Harbor-Raritan Bay, and along the south coast of Long Island (Morreale *et al*., 1989). Turtle sightings off Massachusetts are most frequent in the late summer months (Shoop *et al.,* 1981; CeTAP, 1982; Shoop and Kenney, 1992), when the turtles migrate north to feed. Both loggerheads and ridleys are primarily benthic feeders, and are not as likely as the pelagic-feeding leatherbacks to be observed feeding at or near the water's surface. Therefore, the proposed action's vessels have a greater likelihood of interacting with leatherback turtles since they primarily feed at or near the water's surface. Kemp's ridley turtles are bottom feeders and would spend less time at or near the water's surface. The green turtle and loggerhead turtle are also bottom feeders and not as likely to be encountered in Nantucket Sound (Lazell, 1980; Shoop and Kenney, 1992; Goff and Lien, 1988; Prescott, 2000).

It is unlikely that the physical presence of vessels associated with the construction, operation and decommissioning of the proposed wind farm in Nantucket Sound would contribute to the harassment of feeding and migrating turtles. Additionally, since the turtles do not nest along the beaches of New England, particularly those located along Nantucket Sound, the physical presence of vessels associated with the construction, operation, and decommissioning of the proposed wind farm will not contribute to the harassment of nesting turtles.

5.2.1.3 Water Quality

Increased TSS

An increase in the total suspended solids (TSS) within the water can impact the foraging abilities of the sea turtles, decreasing the visibility of prey species. As previously discussed in Section 5.1.1.3, the suspension of sediments produced by the proposed action's construction are expected to be temporary and localized, as the pile driving hammer and jet plow technology that will be used to install the monopile foundations and the submarine cables, respectively, were selected specifically for their ability to keep sediment disturbance to a minimum. Further, the physical composition of the sands and the physical characteristics of the Sound environment provide reason to believe that any localized turbidity will settle back to the sea floor within a short period of time (one to two tidal cycles). Simulations of sediment transport and deposition for the proposed action demonstrate that jet plow embedment operations will result in a sediment plume largely below 50 mg/L. In places along and immediately adjacent to the cable route, suspended sediment concentrations are predicted to remain at 100 mg/L for approximately 2 to 3 hours. Within Lewis Bay, suspended sediments are expected to remain in suspension for longer periods due to the weak tidal currents, with a plume in excess of 100 mg/L remaining for 2 to 6 hours depending on location and period of cycle. Decommissioning-related impacts will be short-term and localized and are expected to be similar to or less than impacts during construction.

Sea turtles that forage within the area of Nantucket Sound, including those that inhabit or forage in Lewis Bay, are naturally accustomed to substantial amounts of suspended sediments on a regular basis from natural events such as storms and strong tidal currents, and should be minimally impacted by a temporary increase in turbidity from the proposed action activities. Further, sea turtles are mobile and can move away from any disturbance, including any increases in suspended sediments. The impacts of increased TSS on the foraging abilities of sea turtles are expected to be minor.

Contaminated Sediments

Sea turtles bioaccumulate contaminants from their ocean environment, almost exclusively through their food sources. The potential mechanism by which sediments suspended during the proposed action's construction can harm sea turtles is through bioaccumulation of sediment-associated chemicals through ingestion of contaminated prey (indirectly).

As described in Section 5.1.1.3, analysis of sediment core samples obtained from the area of the proposed action indicate that sediment contaminant levels were below established thresholds in reference Effect Range-Low (ER-L) and Effects-Range-Median (ER-M) marine sediment quality guidelines (Long *et al.,* 1995). Therefore the temporary and localized disturbance and suspension of these sediments during the proposed action's construction activities are not anticipated to result in increased contaminants in lower trophic levels. Therefore, sea turtles are unlikely to experience increased bioaccumulation of chemical contaminants in their tissues from the consumption of prey items in the vicinity of the proposed action, and any impacts are expected to be minor. (See Section Table 3.2 of Report 4.1.1-1 for a complete analysis of the sediment core samples).

During the nearshore installation, the release of contaminants from the Horizontal Direction Drilling (HDD) operation within Lewis Bay will be minimized through a drilling fluid fracture or overburden breakout monitoring program, minimizing the potential of drilling fluid breakout into the water. The drilling fluid will consist of water (approximately 95 percent) and an inorganic, bentonite clay (approximately 5 percent). The bentonite clay is a naturally occurring hydrated aluminosilicate composed of sodium, calcium, magnesium, and iron. In the unlikely event of drilling fuel release, the bentonite fluid density and composition will cause it to remain as a cohesive mass on the seafloor in a localized slurry pile similar to the consistency of gelatin. This cohesive mass can be quickly cleaned up and removed by divers and appropriate diver-operated vacuum equipment; thereby minimizing any long-term impacts to protected sea turtles.

Decommissioning-related impacts will be short-term and localized and are expected to be similar to or less than impacts during construction. The suspension of solids are expected to be temporary and localized, as the removal technology that will be used to install the monopile foundations and the submarine cables, respectively, were selected specifically for their ability to keep sediment disturbance to a minimum. Further, the physical composition of the sands and the physical characteristics of the sound environment provide reason to believe that any localized turbidity will settle back to the sea floor within a short period of time (one to two tidal cycles).

5.2.1.4 Reduced Habitat

Activities related to the proposed action construction may cause a temporary reduced availability of habitat for sea turtles in the vicinity of the area of the proposed action. The main anticipated impact would be avoidance of areas of high traffic mainly the route the proposed action-vessels will use to and from the Wind Park. The proposed action's construction is not anticipated to result in permanent changes in sea turtle prey abundance or distribution. Some temporary displacement may occur during periods of noise or high suspended sediments, but this will be limited to areas directly surrounding the given activities, causing both prey species and sea turtles moving to an undisturbed area. Benthic habitat loss due to construction activities may cause mortality to benthic organisms in the area, but similar benthic communities are found throughout Nantucket Sound, enabling sea turtles to find suitable prey in other areas.

5.2.1.5 Habitat Shift

The presence of 130 monopile foundations, six ESP piles and their associated scour control mats in Nantucket Sound has the potential to shift the area immediately surrounding each monopile from a soft sediment, open water habitat system to a structure-oriented system, with potential localized changes to sea turtles, namely the establishment of "fouling communities" within the Wind Park and an increased availability of shelter among the monopiles.

The WTG monopile foundations will represent a source of new substrate with vertical orientation in an area that has a limited amount of such habitat, and as such may attract finfish and benthic organisms, potentially affecting sea turtles by causing changes to prey distribution and/or abundance. While the aggregation of finfish around the monopiles will not attract sea turtles, some sea turtle species may be attracted to the WTGs for the fouling community and epifauna that may colonize the monopiles as an additional food source for certain sea turtle species, especially loggerhead and Kemp's ridley turtles. All four species may be attracted to the monopiles for shelter, especially loggerheads that have been reported to commonly occupy areas around oil platforms (NRC, 1996).

More specifically, loggerheads and Kemp's ridleys could be attracted to the monopiles to feed on attached organisms since they feed on mollusks and crustaceans. According to USFWS (2005), loggerheads are frequently observed around wrecks, underwater structures and reefs where they forage on a variety of mollusks and crustaceans. Leatherback turtles and green turtles however should not be attracted to the monopiles for feeding since leatherbacks are strictly pelagic and feed from the water column primarily on jellyfish (OBIS-SEAMAP, 2002) and green turtles are primarily herbivores feeding on seagrasses and algae. In addition, green turtles are much more likely to be found in shallow warmer waters and are not expected to frequent the Nantucket Sound area with any regularity. All four species of sea turtles have been observed around oil platforms, especially loggerheads which are reportedly the most common species sighted around oil platforms and have been observed sleeping under platforms or next to support structures (NRC, 1996). Kemp's ridley turtles, however appear to prefer more sheltered areas along the coast or in estuaries, bays and lagoons (FWIE, 1996). Therefore, although it is possible that any of the four sea turtle species could be attracted to the monopiles for shelter, the loggerhead is the most likely species to be attracted to the structures for both food and shelter.

Although the monopile foundations would create additional attachment sites for benthic organisms that require fixed (non-sand) substrates and additional structure that may attract certain finfish species, the additional amount of surface area being introduced (approximately 1,200 square feet (111 square meters) per tower, assuming an average water depth of 30 feet (9.1 m) below mean high water (MHW)) would be a minor addition to the hard substrate that is already present (see Section 3.9 of ESS, 2007). Due to the small amount of additional surface area in relation to the total area of the proposed action and Nantucket Sound and the spacing between WTGs (0.34 to 0.54 nautical miles (0.63 to 1.0 km) apart), the new additional structure is not expected to affect the overall environment, benthic community composition, finfish species composition, or populations of foraging sea turtles in the area.

At the end of the proposed action's lifespan, removal of the WTG monopile foundations and ESP piles at the time of decommissioning would result in a localized shift from a structure-oriented habitat near the WTGs and ESP to the original shoal-oriented habitat present prior to construction to the proposed action. However, as the addition of the monopiles would be a minor addition to the hard substrate that was present prior to the construction of the Wind Park, the removal of the WTGs and ESPs will not cause a great impact in the overall habitat structure. Therefore, sea turtle populations that consume colonizing benthic invertebrate prey are not likely to increase due solely to the presence of the monopiles and hence would not be greatly affected by their removal.

5.2.1.6 EMF

Potential direct impacts to listed sea turtles during the normal operation of the inner-array cables and the two submarine cable circuits are expected to be discountable or insignificant. The cable system (for both the inner-array cables and each of the submarine cable circuits) is a three-core solid dielectric AC cable design, which was specifically chosen for its minimization of environmental impacts and its reduction of any electromagnetic field. The proposed inner-array and submarine cable systems for the proposed action will contain grounded metallic shielding that effectively blocks any electric field generated by the operating cabling system. Since the electric field will be completely contained within those shields, impacts are limited to those related to the magnetic field emitted from the submarine cable system and inner-array cables. As presented in Report No. 5.3.2-3 the magnetic fields associated with the operation of the inner-array cables or the submarine cable system are not anticipated to result in an adverse impact to sea turtles, or their prey (ICNIRP, 2000; Adair, 1994; Valberg *et al*., 1997).

The research presented in the technical report on EMF indicates that although high sensitivity has been demonstrated by certain species (especially sharks) for weak electric fields, this sensitivity is limited to steady (DC) and slowly-varying (near-DC) fields. The proposed action produces 60-Hz time-varying fields and no steady or slowly-varying fields. Likewise, evidence exists for marine organisms utilizing the geomagnetic field for orientation, but again, these responses are limited to steady (DC) and slowly-varying (near-DC) fields. 60-Hz alternating power-line EMF fields such as those generated by the proposed action have not been reported to disrupt marine organism behavior, orientation, or migration. Based on the body of scientific literature examined, there are no anticipated adverse impacts expected from the undersea power-transmission cables or other components of the proposed action on the behavior, orientation, or navigation of marine organisms, including listed sea turtle species (Report No. 5.3.2-3).

Because the inner-array cables and the two submarine cable circuits connecting the Wind Park to the landfall will be buried approximately 6 feet (1.8 m) below the seabed, they will not pose a physical barrier to fish passage. The considerable depth to which the cables will be buried will allow benthic organisms to colonize and demersal fish species to utilize surface sediments without being affected by the cable operation. The burial depth of the cables also minimizes potential thermal impacts from operation of these cable systems. In addition, the inner-array and submarine cable systems utilize solid dielectric AC cable designed for use in the marine environment that does not require pressurized dielectric fluid circulation for insulating or cooling purposes. There will be no direct impacts to sea turtle species during the normal operation of the inner-array or submarine cable systems. There will also be no impacts to invertebrate or plankton prey species of sea turtles (indirect impact) during the normal operation of the inner-array or submarine cable systems.

5.2.1.7 Proposed Action Impact Analysis – Routine Activities

The major impact-producing factors affecting sea turtles as a result of the proposed action's activities include noise generated by construction and operational activities; vessel traffic; temporary reduced habitat; and degradation of water quality.

The main underwater acoustical impacts during construction will be limited to that generated by installation of the monopile foundations. An analysis of predicted underwater sound levels perceived by sea turtles from the proposed action's operation show that no injury or harassment to sea turtles are predicted even if an individual were to approach as close as 65.6 ft (20 m) to a monopile when the proposed action is operating at the design wind speed as all increases over hearing threshold at this minimum distance are well below 90 dB. In fact, the proposed action's operation will be inaudible for sea turtles. Therefore, no behavioral effects to sea turtles are anticipated even if an individual were to approach within 65.6 ft (20 m) of the structures. The proposed action's operations will result in discountable or insignificant impacts on sea turtles in Nantucket Sound.

As previously discussed, sea turtles do not appear to be exceedingly disturbed by the physical presence and sound produced by vessels, and the vessel traffic itself (NMFS, 2001; NMFS, 2002). Sea turtles should be able to detect and move away from any proposed action vessel by diving into deeper waters. Any impact will be limited to temporary avoidance of an area; however this is unexpected due to the high volumes of vessel traffic that normally travel the waters of Nantucket Sound. Therefore, the impacts of increased vessel traffic should have minor impacts on listed sea turtles.

Activities related to the proposed action's construction may cause a temporary reduced availability of habitat for sea turtles in the vicinity of the area of the proposed action. The main anticipated impact would be avoidance of areas of high traffic mainly the route the proposed action-vessels will use to and from the Wind Park. The proposed action's construction is not anticipated to result in permanent changes in sea turtle prey abundance or distribution. Some temporary displacement may occur during periods of noise or high suspended sediments, but this will be limited to areas directly surrounding the given activities, causing both prey species and sea turtles to move to an undisturbed area. Benthic habitat loss due to construction activities may cause mortality to benthic organisms in the area, but similar benthic communities are found throughout Nantucket Sound, enabling sea turtles to find suitable prey in other areas. Therefore, the impacts of reduced habitat should have minor impacts on listed sea turtles.

Sea turtles that forage within the area of Nantucket Sound are naturally accustomed to substantial amounts of suspended sediment on a regular basis, from storms and strong tidal currents, and should be minimally impacted by a temporary increase in turbidity from the proposed action's activities, including the sea turtles that may inhabit or forage within Lewis Bay. Further, sea turtles are mobile and can move away from any disturbance, including any increases in suspended sediments. The impacts of increased turbidity on the foraging abilities of sea turtles are expected to be minor.

5.2.1.8 Summary and Conclusion – Routine Activities

Routine activities associated with the proposed action's construction, operation, maintenance and decommissioning will have minor impacts on the sea turtles species that may be found in that area. Some temporary avoidance of the area of the proposed action may occur due to elevated acoustic, vessel harassment and decreased water quality, however this should be short-lived and normal conditions are expected to resume once construction and decommissioning activities have ceased. During operations, very few activities would occur that could have long term or extensive effects on the sea turtles using the proposed action area. The one effect that may result in attraction of benthic feeding sea turtles to the project area is the creation of hard substrate fouling and macroninvertebrate community on the rock armor and monopiles. This could result in increased feeding opportunities for the loggerhead and Kemp's ridley sea turtle species. Creation of the hard substrate fouling and macroinvertebrate community may also result in potential increased vessel traffic and fishing interactions that may have a minor effect on sea turtles that may be present due to increased feeding opportunities.

5.2.2 Sea Turtles-Non-routine and Accidental Events

Accidental, and unexpected events associated with the proposed action could impact sea turtles. Such impacts would primarily be the result of oil spills, cable repair, vessel collisions, and geotechnical and geophysical investigations.

5.2.2.1 Oil Spills

Sea turtles can be harmed if they surface in an oil slick to breathe. Oil can affect their eyes and damage airways or lungs. Sea turtles can also be affected by oil through contamination of the food supply or by absorption through the skin. In addition, sea turtles are vulnerable through all life stages. Other aspects of sea turtle biology including their lack of avoidance behavior in regard to oil slicks, indiscriminate feeding in convergence zones and large predive air inhalations are all reasons for their extra sensitivity to oil/chemical spills (Shigenaka *et al*., 2003).

Existing research suggests that sea turtle eggs, embryos and hatchlings are more vulnerable to oil than adults. However, none of these life stages occur in Nantucket Sound or in the Northeast. Though less vulnerable than earlier life stages, research suggests that adult sea turtles are still quite sensitive to oil/chemical spills. A study of loggerhead turtles found that they showed no avoidance behavior when encountering oil slicks (Shigenaka *et al*., 2003). They also seemed unable to distinguish between food and tar balls. Because they inhale large volumes of air before diving and resurface regularly, the turtles are exposed to oil vapors for longer periods of time. Research on the loggerheads also found that any oil ingested was retained for several days, leading to greater risk to internal organs (Shigenaka *et al*., 2003).

There are very few laboratory studies that investigate the impact of oil on adult sea turtles. One such study conducted in 1986 on loggerhead turtles found the turtles' health was adversely affected by both chronic and acute exposures to crude oil (Lutcavage *et al*., 1995). Results showed that the turtles' skin sloughed off, with inflamed, abnormal and dead cells. It took several weeks for the turtles to recover which led to an increased risk of infection. Exposure to oil also led to changes in blood chemistry with a decrease in the volume of red blood cells and an increase in white blood cell production. In addition, the turtles in the study did not display any avoidance behavior towards oil. Another study found similar results with cell abnormalities in the skin, alteration of respiratory patterns and blood cell dysfunctions in turtles exposed to crude oil (Lutz and Lutcavage, 1989). In addition, the research found that the turtles had ingested oil and it appeared in their feces. Ingestion could have physiological effects that could be fatal.

Overall, there is very little species-specific information on the impact of oil to sea turtles. However, because of its small population size and limited nesting distribution, Kemp's Ridley sea turtle is considered to be especially vulnerable to oil/chemical spills (Lutz and Lutcavage, 1989). In summary, existing literature suggests that sea turtles are especially sensitive to oil/chemical spills. However, the type of oil, length of exposure, condition of the oil in terms of weathering, and life stage at which sea turtles are exposed all play a role in the impact to the species. While the probability of occurrence of a large oil spill is very small, should one occur during the season that sea turtles are present in Nantucket Sound, the potential impacts would be moderate, requiring implementation of special procedures to reduce potential harm to sea turtles.

5.2.2.2 Cable Repair

Many of the types of disturbances that would occur during cable repair activities are smaller and shorter duration, but of similar type, to those that would occur during cable installation. A relatively short distance along the sea floor would be disturbed by the jetting process used to uncover the cable and allow it to be cut so that the ends could be retrieved to the surface. In addition to the temporary loss of some benthic organisms, there would be increased turbidity for a short period, and a localized increase in disturbance due to vessel activity, including noise and anchor cable placement and retrieval. Given the small area, short duration, and low probability of a cable repair occurrence, potential adverse impacts from cable repair activities on the listed sea turtles would be discountable or insignificant.

5.2.2.3 Vessel Collision with Monopile

The extent of potential impacts that could result from a vessel collision with a monopile largely depends on the extent of damage to the monopile or vessel, as well as the nature of the vessel. Some smaller vessels would merely strike a glancing blow and suffer some hull damage but not sink. Other vessels may suffer enough damage to sink, causing a small release of fuel and debris. A larger vessel, such as an oil tanker, would most likely cause a collapse of the monopile, also resulting in a small release of lubricating fluid. If oil being transported were to be released, then depending upon the quantity released, an oil spill could directly affect listed sea turtles (see section 5.2.2.1). Repair of a damaged or collapsed monopile would create short term and localized disturbances to the benthos, water column, and pelagic organisms similar to the construction and decommissioning of a single monopile, albeit in reverse order and combined in a single event. Other than the oil spill scenario, since these disturbances are localized to the monopile they are unlikely to adversely affect listed sea turtle species, and therefore potential adverse impacts resulting from a vessel collision with a monopile and the associated repair activities on the listed sea turtles would be discountable or insignificant.

5.2.2.4 Geotechnical and Geophysical Investigations

Many of the types of disturbances that would occur during the geotechnical and geophysical investigations are short term and very localized. A very small area of the sea floor would be disturbed by coring activities, either at the core hole or associated with the coring vessel anchor placements. It is likely that the duration of activity at any one coring location would be no more than a few days. The high resolution geophysical survey work, including collection of shallow (Chirp) and intermediate depth (Boomer) subbottom profiler data and sidescan sonar and magnetometer data, uses mobile gear towed behind a vessel, and would not result in bottom disturbance, nor does it result in activity at a fixed location. The geotechnical investigations would result in a negligible temporary loss of some benthic organisms, and a localized increase in disturbance due to vessel activity, including noise and anchor cable placement and retrieval. While the towed gear has the potential to result in interaction with sea turtle, the speed of towing, typically about 1 knot, minimizes the potential for entanglement or vessel strikes. Given the small area of disturbance, short duration of activities, and slow speed of mobile surveys, potential adverse impacts from geotechnical and geophysical investigations to the listed sea turtles would be discountable or insignificant (Additional details on geotechnical and geophysical field investigations are presented in Section 2.7 of the DEIS).

5.2.2.5 Proposed Action Analysis – Non-routine or Accidental Condition

While improbable, an oil spill would have moderate impacts on sea turtles within Nantucket Sound. The type of oil, length of exposure, condition of the oil in terms of weathering and life stage at which the sea turtle is exposed to the spill will all play a role in the impact on the animal. While some oil products will be present within the proposed action's structures, the amount of oil being used will lead to less severe impacts in the event of a spill. In general, researchers concluded that as oil weathers in the marine environment over time, its toxic effects on sea turtles decreases. The negative effects on sea turtles discussed above likely represent a worst-case scenario based on the impact from a large, fresh oil spill which reaches turtle breeding areas on shore. In the case of Cape Wind, the amount of oil being used and distance to shore would most likely lead to less severe impacts than described above in the event of a spill. In addition, turtle breeding areas are located well south of the proposed action area; therefore, no breeding areas or early life stages would be affected by a potential spill.

5.2.2.6 Summary and Conclusion – Non-routine or Accidental Condition

Activities associated with the proposed action that are non-routine or accidental will have minor impacts overall on the sea turtle species that may be found in the area. The unplanned event that may have the greatest adverse effect on sea turtle species includes the unlikely chance of an oil spill, in which case impacts could be moderate.

5.3 Birds

Piping Plover

Potential avian impacts associated with construction and operation of the proposed action could include loss of habitat; disturbances associated with the presence or activity of construction equipment; disturbances such as barriers to flight paths due to the presence of the turbines; and the risk of collision with WTG structures. Impacts associated with decommissioning activities are expected to be similar to or less than construction activities. Individuals that could potentially be impacted by the proposed action include those from the New England and Atlantic Canada subpopulations, as well as a few interior breeding birds that migrate east before migrating south to locations along the Atlantic Coast.

There are potential impacts that could occur as a result of non-routine, accidental, or unplanned events including oil spills or cable maintenance activities.

Roseate Tern

Potential impacts to roseate terns could occur from routine activities during construction, operation, and decommissioning of the proposed action including short or long-term habitat loss or modification; disturbances due to the presence and maintenance of the Wind Turbine Generators (WTGs); risk of collision; increased predation; and increased human activity such as increased vessel traffic. In addition, there are potential impacts that could occur as a result of non-routine, accidental, or unplanned events associated with oil spills, monopile collapse, and cable repair.

5.3.1 Routine Activities

5.3.1.1 Piping Plover

5.3.1.1.1 Habitat Loss or Modification

Habitat loss or modification associated with construction or operation of the proposed action is not anticipated for the piping plover as the proposed wind turbine generators (WTGs) would be located offshore, at least 5 miles (8 km) from the nearest nesting or staging habitat (Figure BA-9). The proposed landfall of the transmission cable would not occur within breeding habitat. There are no critical habitat designations in Massachusetts, therefore, the proposed action would not impact critical habitat.

The proposed location of the landfall of the transmission cable is on the northeastern side of Lewis Bay at the end of New Hampshire Avenue in Yarmouth. Neither the proposed cable nor landfall would cross piping plover breeding habitat. The closest nesting location to the proposed landfall is approximately 1.5 mile (2.4 km) at Kalmus Beach/Dunbar Point in Hyannis. The closest distance of the submarine cable system to the nearest piping plover nest site on the seaward side of Great Island is 0.8 mile (1.3 km) (Figure BA-9). The buried cables at their closest point would occur approximately 820 ft (250 m) from Kalmus Point/Dunbar Beach and approximately 1,210 ft (369 m) from Great Island. In addition, since the shoreline would be drilled under for cable placement, there would be no physical disturbance of beach areas during construction or operation.

Loss of foraging habitat is not anticipated as the majority of foraging during the breeding season takes place in proximity to nesting locations. Loss of pre-migratory staging or foraging habitat is not anticipated as the landfall would not occur in proximity to reported staging areas (USFWS, 1996).

5.3.1.1.2 Disturbance

In general, disturbances (not associated with the project) around nest sites can result in the abandonment of nests, and ultimately, decreased breeding success. Available data regarding responses to disturbance suggest that flushing distances (from the source of disturbance) of incubating birds vary among sites and individuals. Disturbances resulting in flushing occurred as far away from nests as 689 ft (210 m), 984 ft (300 m), and 571 ft (174 m) at Nova Scotia, Virginia, and Maryland beaches, respectively (USFWS, 1996). The recommended disturbance buffer around nest sites is typically a 164 ft (50 m) buffer; however, at Maryland sites it is 738 ft (225 m) (USFWS, 1996). The mean flushing distance at Massachusetts nest sites is 24 m (the maximum disturbance distance was not provided) (USFWS, 1996). For non-incubating birds, the maximum disturbance distances reported for pedestrian, vehicles, pets, and kites are 197 ft (60 m), 230 ft (70 m), 328 ft (100 m), and 394 ft (120 m), respectively (USFWS, 1996). Causing parents or juveniles to flush while foraging may stress juveniles enough to negatively influence critical growth and development. Potential disturbances due to the proposed action during construction and decommissioning associated with increased human activity, the presence and operation of large equipment, and increased boat traffic offshore of nesting sites located closest to the proposed landfall, would be temporary but may result in some level of disturbance to piping plover if activities occur during the nesting season. It is possible that a tracking system consisting of a wire, for the operation of the drill head may be placed across the beach. This would be a discountable, temporary activity that would not disturb a nesting pair in the area more than a person walking on the beach.

The proposed landfall site is 1.5 mile (2.4 km) from the nearest nesting beach and, therefore, onshore construction activities associated with the landfall site are not anticipated to impact nesting piping plover. Since HDD technology would be used for making the landfall, there would be no physical disturbance of beach areas. The buried cable would be 820 ft (250 m) offshore from the nearest piping plover nesting location at Kalmus Point/Dunbar Beach. Due to the separation of the submarine cable from the nearest nesting beaches, disturbances associated with offshore construction or operation activities are anticipated to be discountable for nesting piping plover. However, increased boat traffic and cable trenching could result in flushing nesting birds. The area already experiences heavy boat traffic and these disturbances would be temporary and would therefore not be expected to impact nesting success. If the cable is buried outside of the nesting season, the impact is anticipated to be discountable. The placement of a wire on the beach (and seafloor) to help guide and track the drill head would result in disturbance essentially equal to a person walking on the beach. This activity may flush an incubating bird if it were to occur during the breeding season in the vicinity of a nesting pair; however, this disturbance may be avoided by maintaining a 300 m buffer (or greater pending communication with USFWS) around any nesting area.

5.3.1.1.3 WTG Presence and Rotor Movement

Breeding Season

During the breeding season, piping plover are mainly sedentary as they forage on invertebrates in the inter-tidal zone near nest sites. During this period, plovers mainly travel by walking or running between proximal foraging and breeding sites, however, some plovers may undertake short flights to foraging areas. Their regular daily movements are not expected to result in crossings of the proposed action area or other areas in Nantucket Sound. However, there have been some observations of plovers during the breeding season departing land and heading for the horizon. There was a potential that these observed departures resulted in crossings of Nantucket Sound (Report No. 4.2.9-1).

Unusual crossings of Nantucket Sound during the breeding season could include the crossings of failed breeders or unpaired birds seeking alternate habitat or a mate. However, a study conducted on outer Cape Cod indicated that most breeding plovers did not change mates or move to new territories between nesting attempts (MacIvor, 1990). Aerial and boat surveys conducted in 2002, 2003 and 2004 in Nantucket Sound did not detect such movements in any of the study areas, although survey methods used were limited in their ability to detect small, light-colored birds.

There are no known flight corridors for plovers over the Sound during the breeding season. There are no topographical features such as shortest crossings that are expected to direct occasional flights over the Sound into HSS. Due to the relatively sedentary behavior of piping plover during the breeding season, the WTGs are not anticipated to create a major barrier to the flight paths of piping plover during the breeding season.

Migration and Dispersal

The majority of Atlantic Coast piping plover migratory movements is presumed to take place along the outer beaches of the coastline (USFWS, 1996). Most movements are presumed to occur along a narrow flight corridor, and offshore and inland observations are rare (USFWS, 1996). There is a great deal of uncertainty surrounding the migratory flight paths of piping plover. The hypothesized movement of piping plover along the shoreline during migration is based on observations of birds at stop-over locations along the Atlantic Coast. However, the paths actually taken between these stop-overs are not documented. Some birds may occur inland or offshore while migrating if blown off course by weather events, although sightings away from the outer beaches, either inland or offshore, are rare (USFWS, 1996). The birds that breed or stop-over on islands in Nantucket Sound and Vineyard Sound would make over-water crossings while accessing these locations. Therefore, there is a greater potential that piping plover could occur within the proposed action area during migratory or post-breeding dispersal movements. The number of annual piping plover crossings of HSS is unknown. However, since the best available information suggests that migration movements are believed to largely occur along the outer beaches, it is expected that the presence of the WTGs will not present a major barrier to the flight path of migrating piping plover. Further investigation into piping plover movement patterns with telemetry studies would provide a more reliable assessment of risk of barrier effects to piping plover. Although additional studies including telemetry, could provide information, current technology and survey methods are limited.

5.3.1.1.4 Risk of Collision

The potential exists for piping plover to collide with WTG structures, including the blades and tubular towers during the breeding, staging, and migration periods. The results of available terrestrial mortality studies conducted in primarily terrestrial environments for general avian species indicate that the majority of collisions with man-made structures take place at night during periods of inclement weather (Kerlinger, 2000). There is limited mortality data available regarding the conditions of greatest risk of collision at offshore wind sites; however Huppop *et al.* (2006) determined that risk of collision with man-made structures located offshore is elevated during rain and fog. Birds that fly within the rotor zone of the proposed turbines (75.5 to 440 ft [23 to 134 m]) during periods of low visibility would be at greatest risk of collision.

Breeding Season

Height of flight is an important factor to consider when assessing the risk of collision to piping plover. During the breeding season, piping plover have been documented flying low over the water (or adjacent land) while accessing foraging locations, typically less than 33 ft (10 m), but sometimes at higher, unknown altitudes (Report No. 4.2.9-1). These observations included departures toward land, beyond the horizon, that may have resulted in crossings of Nantucket Sound (Report No. 4.2.9-1). Crossings of Nantucket Sound are expected to be sporadic during the breeding season as plovers are mainly sedentary and make small scale movements between nesting and foraging locations along the beach. Regular daily movements of breeding birds are not expected to result in crossings of Nantucket Sound. The exceptions would be occasional crossings of Nantucket Sound by individuals accessing alternate nesting or foraging areas. Unusual crossings could be conducted by failed nesters or unpaired individuals traveling between the mainland and Nantucket or Martha's Vineyard in search of habitat or a mate. However, a study conducted on outer Cape Cod indicated that most breeding plovers did not change mates or move to new territories between nesting attempts (MacIvor, 1990). More information is required to determine the likelihood of piping plover over-water movements during the breeding season due to limited available information.

As crossings of Nantucket Sound would be sporadic during the breeding season, the potential of piping plover encountering a WTG is expected to be low. The risk of collision during a crossing of the area of the proposed action depends on the height of flight, visibility conditions, and piping plover turbine interaction behaviors (which are not known). Hatch and Brault (2007) (Report No. 5.3.2-1) estimated the number of piping plover turbine encounters during a single crossing of the proposed action area, assuming all turbines were aligned perpendicular to each bird's path, based on three different flight height scenarios: If all individuals fly below 30 m, the expected encounters per crossing would be 0.07; if all birds fly in the rotor swept zone (75.5 to 440 ft [23 to 134 m]), there would be 0.67 encounters; and if flights are evenly distributed from

30 to 600 m then there would be 0.13 encounters. The authors assume that all encounters with stationary monopiles would be avoided; however, other turbine collision models assume (Podolsky, personal communication) there is a risk of collision with stationary monopoles as well as moving blades. The authors suggest that, based on high avoidance rates estimated for other species, the likelihood of collisions resulting from encounters is low. However, piping plover turbine interaction behaviors and movement patterns during the breeding season across HSS are needed to better assess the likelihood of turbine encounters and collisions in HSS.

Migration

Migratory movements and post-breeding dispersal could result in piping plover crossings of Nantucket Sound, and potentially HSS. Piping plovers migrate both during the day and night (O'Brien, *et al*., 2006). The risk of collision of piping plover during migration movements would be based on flight frequency through the proposed action area, height of flight, visibility conditions, and turbine avoidance behaviors (which are not known). It is not known how many plovers may cross Nantucket Sound during migration, what flight paths they take, or their average flight height.

Observations suggest piping plover in the breeding season fly over water at relatively low heights, generally less than 33 ft (10 m), but sometimes at higher, unknown altitudes (Report No. 4.2.9-1). It is not known at what altitude piping plover migrants travel. In one radar study, shorebirds migrating from Nova Scotia flew at an overall mean altitude of 2,000 m (median 1,700 m) (Richardson, 1979). These birds are known to cross large expanses of land and water and make stop-overs at staging areas along the way. However, they make much larger scale movements than piping plover. Summarizing numerous studies, Richardson (1978) determined that most birds migrate in peak numbers using the advantage of following winds relative to the preferred direction. It is expected that following winds would be important for birds that migrate long distances, especially over barren landscapes (Richardson, 1990), such as the open ocean.

After review of peak counts of post-breeding adults and fledglings since 2000, Hatch and Brault (2007) noted that as many as 70 staging birds have been observed on South Beach, Chatham during the fall staging period, and as many as 1,400 migratory plover have been counted in Massachusetts (Report No. 5.3.2-1). There is known staging habitat on Cape Poge, Martha's Vineyard and possible staging habitat on Nantucket (USFWS, 1996). Individuals that stage in areas of Nantucket Sound could include birds from Atlantic Canada, northern New England, and potentially a few interior breeding birds that migrate east before heading south to Atlantic Coast wintering grounds. An unknown percentage of the Atlantic population could move through Nantucket Sound during migration. There is the potential that spring and fall migratory movements among stop-over sites on the Atlantic Coast could result in piping plover crossings of HSS. Hatch and Brault (2007) (Report No. 5.3.2-1) suggest that if piping plover were to depart South Beach for a stop-over destination on Long Island, NY, and if the birds were to fly at rotor height, they would be at risk of collision with the proposed WTGs.

The periods of greatest risk of collision are during periods of low visibility, at night, during crepuscular periods, and during periods of inclement weather (Kerlinger, 2000; Huppop *et al.*, 2006). Nisbet (personal communication) noted that a study conducted by Winkelman in 1992 with thermal image intensifiers found that 1 of 40 (2.5 percent) of nocturnally migrating birds passing through the rotor-zone of a land-based wind farm collided with turbines. Studies have demonstrated that steady burning FAA obstruction lighting (Gehring and Kerlinger, 2007; Shire *et al*., 2000) and some other types of lighting on mainly land-based tall structures can attract or disorient night migrating birds, resulting in collisions with those structures. Huppop *et al*. (2006) found that risk of collision with lit man-made obstacles offshore is also elevated during periods of fog, rain, or low ceiling height. The birds involved with collisions with a lit platform located offshore were primarily night migrating songbirds and a few other species including one dunlin (*Calidris alpina*) and four large gulls (Huppop *et al*., 2006). Shorebirds are rarities among reported collisions at 47 mainly land-based and some coastal communication towers in the U.S. that are lit and are typically over 200 ft (61 m): 1 spotted sandpiper (*Actitis macularia*), 1 solitary sandpiper (*Tringa solitaria*), 1 red phalarope **(***Phalaropus fulicaria)*, 1 upland sandpiper (*Bartramia longicauda)*, 1 least sandpiper (*Calidris minutilla)*, 1 willet (*Catoptrophorus semipalmatus)*, and 1 killdeer (*Charadrius vociferous*) were reported at the 47 towers as of 2000; shorebirds represented 5 percent of fatalities reported at these towers (Shire *et al*., 2000).

Natural sources of nighttime lighting (i.e., moonlight or starlight) may decrease the risk of plover collisions if their movements result in nighttime crossings of the proposed action area. The lighting mounted on nacelles may help plovers detect the presence of the WTGs (not necessarily the blades) and may facilitate avoidance of the WTG area. At the Nysted and Horns Rev wind farm in Denmark, all the wind turbines are equipped with yellow navigational lighting. In addition, all wind turbines positioned at the outer edge of the wind farm are equipped with two medium intensity flashing red lights on the top of the nacelles. The lights operate at a frequency of 20 to 60 fpm (Petersen *et al.,* 2006). Radar observations suggest that birds approached the turbines at closer distances at night than during the day, and that more birds entered the wind farm at night than during the day; however, observations indicated avoidance behavior of the turbines by nighttime migrants. The typical distance at which an avoidance reaction occurred was 1,640 ft (500 m) from turbines at night and 1.9 mile (3 km) during the day (Petersen *et al.,* 2006). It may be that that migrating birds react later to the turbines at night due to decreased visibility, but are eventually able to detect the turbines due to lighting mounted on the nacelles or natural sources of night lighting. Another study conducted with vertically oriented radar suggests that migrating birds may also react to turbines by 'vertical deflection' at night instead of the linear avoidance primarily observed during the day (Blew *et al.,* 2006 *as cited by* Petersen *et al.,* 2006).

It may be that plovers wait out inclement weather conditions prior to departing staging locations. Petersen *et al.* (2006) observed a substantial decrease in the volume of migrating birds at an offshore facility in Europe during periods of elevated collision risk. However, there is the potential that plovers could depart in fair weather conditions but could encounter severe weather en route. At staging locations, migrants have been observed following early fall hurricanes (USFWS, 1996). Weather events could potentially push migrants inland or offshore. Telemetry could be used to assess piping plover occurrence and movements through HSS at night and during inclement weather. More visual data, collected in a variety of weather conditions during the day and at night, could help to determine the potential piping plover flight heights and behaviors in HSS. Additional boat and aerial surveys may not address the existing data gaps;

although additional studies including telemetry, aerial surveys and infrared imaging could provide additional information, current technology and survey methods are limited.

Collision Probability Modeling

The following information provides detail on the methods and results from the Applicant's collision probability modeling. In addition, Appendix A includes a response to comments from a December 2007 review of this modeling approach. MMS asks the FWS to consider this section as well as Appendix A as it evaluates the best available information provided on collision risk modeling for this species.

Hatch and Brault (2007) (Report No. 5.3.2-1) used the Band model to estimate a 91 to 99 percent plover turbine avoidance rate based a range of known avoidance rates calculated for other species. These avoidance rates are consistent with rates calculated at a few existing wind farms in the U.S. where mainly geese and raptor species were estimated to have avoidance rates greater than 95 percent. Fernley *et al.* (2006) calculated the avoidance rates of geese at four operating land-based wind farms in the U.S. using the Band Collision Risk Model. The avoidance rates calculated at the four facilities ranged from 99.82 percent to 100 percent despite high usage by geese at these wind farm sites. Whitfield and Madders (2006) used the Band Collision Risk Model to estimate the avoidance rate of hen harriers (*Circus cyaneus*) at eight wind farms in the U.S. Estimates were: 100 percent at 6 sites, 99.8 percent at 1 site, and 93.2 percent at 1 site. Other avoidance rates reported include: 99.62 percent mainly for gull species at Blyth Harbor in Northeast England, 99.5 percent for golden eagle (*Aquila chrysaetos*) at a U.S. facility, and 99.98 percent for passerines at the Oosterbierum wind farm in the Netherlands (Chamberlain *et al*., 2006). There are, however, limitations to the Band Collision Risk Model, as it does not account for differences among bird activities and behaviors under a range of conditions, and because avoidance rates exhibited by a range of species are understudied (Chamberlain *et al.*, 2006).

Chamberlain *et al.* (2006) warned against the inaccuracies that can result in collision models that are based on the avoidance rates calculated for other species. Hatch and Brault (2007) (Report No. 5.3.2-1) provided an estimate of the number of plover crossings of the proposed action area per year. This estimate was based on the number of breeding plovers from Massachusetts northwards, including the Atlantic Canada population. It was estimated that 2,458 plovers cross the Massachusetts coastline over the course of a year (based on adults in spring and fall, and fledglings). MassWildlife suggested that less than 200 piping plover would cross HSS in a year (Report No. 5.3.2-1). This figure was applied to the model with varying scenarios of flight height and collision probability. Based on an avoidance rate of 98 percent, if all flights occurred in the rotor zone, one piping plover collision would occur in 5.5 years; if all flew below 98 ft (30 m), there would be one collision in 50 years; if flight heights were distributed between 98 to 1,968 ft (30 to 600 m), there would be one collision in 28 years. Using the avoidance rate of 91 percent, there would be 1.2 collisions per year if birds flew exclusively in the rotor zone, 1 collision in 12 years if all birds flew below 98 ft (30 m), and 1 collision in 6 years if flight heights were distributed between 98 and 1,968 (30 and 600 m). The model inputs are based on the best available information and the authors emphasize the uncertainties surrounding the model including the lack of information regarding piping plover occurrence and flight behavior in HSS, as well as the lack of a species-specific avoidance rate. Site-specific post-construction visual data describing avian avoidance behavior would be the most reliable way to access species specific avoidance rates of WTGs at the proposed action area. Appendix B to the BA provides a description of the monitoring and reporting measures by the applicant aimed at detecting avian avoidance and collision rates should the proposed action be approved and operated.

A population viability analysis (PVA) was developed by Brault (2007) (Report No. 5.3.2-4) using the most recent breeding population trends of both the Atlantic Canada and New England population. The model estimated a range of mortality associated with the proposed action that could be tolerated by the population without increased risk of extinction or decreased probability of recovery goals (the author used 600 breeding pairs for New England, although the current recovery goal is 625 pairs; the correct recovery goal of 400 pairs was used as the Atlantic Canada threshold). The author modeled varying kill rates with no growth and intermediate growth scenarios. It was estimated that a take of up to 5 piping plover per year would not influence the likelihood of achieving Atlantic Coast recovery goals, or influence the probability of extinction. It was estimated that the increase in the risk of extinction was low over a period of 50 years with wind farm fatalities up to 20 birds per year, given that there are no changes in available breeding and wintering habitat. Fatalities of 1 to 5 birds per year, however, have a large effect on the extinction probability of the Atlantic Canada population over a longer life of the project (25-50 years). It was determined that changes in the annual survival rate had 2.25 times the effect on population dynamics than did changes in productivity. The author emphasized that the potential impacts associated with the proposed action are greatly dependent on the level of management efforts. The PVA used a New England recovery goal of 600 breeding pairs instead of the actual 625 breeding pairs. This discrepancy in 25 birds is likely an insignificant factor to the wide range of parameters factored into the model; however, it represents a flaw in the model.

Assuming the estimated worst case scenario of 1.2 wind farm-related piping plover fatalities per year with the low turbine avoidance rate of 91 percent, calculated by Hatch and Brault (2007) (Report No. 5.3.2-1), the recent PVA model suggests that the proposed action would not significantly impact the probability of achieving recovery goals or the influence the probability of extinction. However, there is a large range of uncertainty surrounding the collision mortality estimate. The actual number of crossings of the proposed action area per year, the average height of flight during crossings, and the turbine avoidance rates specific to piping plover are not known. The estimate of 1.2 wind farm-related fatalities is conservative because it assumed that piping plover exhibit a low turbine avoidance rate and that all birds fly through HSS at rotor height. The assumption that all piping plover would cross the proposed action area at rotor height is likely inaccurate; however, it is appropriate to be conservative in the absence of definitive baseline information describing plover migration through HSS.

Aerial and boat surveys conducted in Nantucket Sound documented no piping plover crossings of the proposed action area. However, these surveys were restricted to periods during the day and during fair weather. Additionally, there are significant limitations to the detection of small light-colored shorebirds during visual surveys conducted from a boat or a plane. There are no topographical features that are expected to funnel piping plover through the HSS, therefore crossings of the proposed action area are expected to be small in relation to the number of birds that could potentially cross Nantucket Sound over the course of a year.

To gain greater certainty in the collision probability model, Hatch and Brault (2007) documented that more information would be required to assess piping plover use of the proposed action area during migration and the breeding season, during the day and at night, and during a range of weather conditions. As in any modeling effort, more information is always better than less in terms of reducing uncertainty in extrapolating the model to real-life conditions. In this case, some information is available to assess piping plover use of the proposed action area during the day for migration and the breeding season; however the quantity is limited, especially during the night and during inclement weather, and leads to some amount of uncertainty.

Summary

Piping plover crossings of the proposed action area may occur during low visibility periods which could lead to the potential for increased risk of collision during breeding and staging periods, and during migration. Data on plover occurrence, flight behavior, and movement patterns in HSS during periods of low visibility and at night is not available.

The risk of collision during periods of restricted visibility is high. Studies conducted at offshore wind farms in Europe suggest that flight activity of waterbirds offshore during inclement weather (at night) during migration is reduced (Peterson *et al.,* 2006). Decreased occurrence in the project area at night during inclement weather would result in decreased probability of collision. There are some project features which may reduce the risk of collision if plovers were to occur in the project area at night. Plovers may avoid WTGs due to natural light sources (i.e., starlight or moonlight). The FAA lighting mounted on the nacelle of the turbines may also allow plovers to visually detect the towers (not necessarily the blades) and may facilitate avoidance of the WTG area as it is mainly passerine species that are known to become disoriented by artificial lighting on tall structures. However, because data is not available regarding plover activity in HSS during these light restricted periods, it is appropriate to be conservative and presume that adverse impacts associated with risk of collision during these periods may be moderate for roseate plovers.

5.3.1.2 Roseate Tern

5.3.1.2.1 Habitat Loss or Modification

Terns traveling or foraging in the proposed action area could potentially be impacted by habitat loss or modification during construction, operation, and decommissioning activities. Some species of birds are more sensitive to disturbances than others and can be displaced up to hundreds of meters from the source of the activity (Gill, 2005). Breeding terns may be most sensitive to construction and operation disturbances during the breeding season when they have increased energy demands. There is a potential for the creation of habitat for prey fish due to changes of the substrate, as well as the creation of perching habitat which may attract foraging or resting roseate terns.

There is no available breeding habitat within or in close proximity to the proposed action's boundary, and the transmission cable and proposed landfall would not cross breeding locations. All points along the transmission cable would be greater than 15 mile (24 km) to the nearest breeding location in Nantucket Sound on Monomoy Island. The closest edge of the proposed action area in HSS is greater than 12.9 mile (20.8 km) to Monomoy Island and 8.6 miles (13.8 km) from the closest potential breeding habitat on Muskeget Island. Therefore, construction and decommissioning activities would not result in the loss of breeding habitat. As there are no critical habitat designations for roseate tern in Massachusetts, critical habitat areas will not be impacted.

Terns travel substantial distances (16 to 19 mile [25.8 to 30.6 km]) from their breeding locations to access foraging habitat and therefore terns may be affected as they travel or forage in the vicinity of the proposed action.

Construction, operation, and decommissioning activities could directly deter roseate terns or their prey from the proposed action area resulting in the temporary or permanent loss of habitat. Baseline surveys conducted in Nantucket Sound, documented relatively low tern use of HSS in relation to other locations in the Sound: during the breeding period, of the total number of terns observed in 2003 during the MAS surveys, 1.5 percent occurred in HSS, 5.3 percent in Monomoy-Hankerchief Shoals (MHS), 2.5 percent in Tuckernuck Shoals (TS), and 90.7 percent were outside of shoal study areas (Perkins *et al.,* 2004a; Sadoti *et al.,* 2005a). In 2004, of all the terns observed, 0 percent occurred in HSS, 0.7 percent in MHS, 0 percent in TS, 99.3 percent were outside of the shoal study areas. Of the 2,888 total terns observed during the Applicant's breeding season surveys, 9.6 percent occurred in HSS, 2.6 percent in MHS, 5.7 percent in TS, and 82.1 percent were outside of the shoal study areas (USACE 2004. Report No. 4.2.4-3, 4.2.4-8, and 4.2.4-10). During the staging and migration periods, in 2002, 6 percent of the total terns observed were within of shoal study areas; in 2003, 8 percent were observed within the shoals; and in 2004, 7 percent were observed within the shoals (Perkins *et al.,* 2003; Perkins *et al.,* 2004b; Sadoti *et al.,* 2005b). During surveys, the majority of terns were observed over shallow waters close to the shorelines of Cape Cod, Martha's Vineyard, and Nantucket (Figure BA-12). HSS is not considered a primary foraging location (refer to Section 4.1.3.2, *Results of Surveys and Available Information* for a summary of additional results and information used in this assessment).

Terns are known to regularly forage near recreational fishing boats, ships, and other man-made structures. Terns and gulls are among species of birds that have been observed in the vicinity of operating turbines at European offshore facilities (Everaert and Stienen, 2006; Petersen *et al.,* 2006; Pettersson, 2005). Roseate terns would likely continue to forage and travel in the vicinity of construction activities and operating WTGs, assuming that their food sources are not temporarily displaced during construction.

Roseate terns have been observed to have decreased breeding success during periods of low food availability (Safina *et al.,* 1988). The effects of habitat loss due to development are dependent on the amount of habitat lost and the food resources available at alternative sites (Maclean, 2006). The roseate tern's primary food source is sand eel (*Ammodytes americanus*) and its locations are variable. Important foraging habitat in the area varies seasonally and on a daily basis with the tide cycle.

Vibrations from pile-driving could startle and temporarily displace prey fish from the proposed action area. Increases in turbidity from cable trenching could temporarily impede fish foraging and navigation in disturbed areas (Jarvis, 2005). Construction activities could affect fish and benthic communities up to 328 ft (100 m) from the activity (Nedwell *et al.,* 2004 *as cited by* Gill, 2005). However, impacts to foraging habitat are anticipated to be discountable as construction activities would be temporary and localized within the proposed action area. A jack-up barge (approximately 172 square feet [15.9 m^2]) with a crane would be used to install the monopiles. There would be a total of two pile driving rams used to fix the 130 monopole structures into the seabed and it is unlikely that both rams would be used simultaneously. The hollow monopoles are expected to trap the majority of sediment displaced during pile driving.

Sediment suspended by trenching during cable installation is expected to be localized (20 milligrams/liter within 1,500 feet [457 m] from the trench) and is expected to quickly resettle (within minutes or up to a few hours) (Report No. 4.1.1-2). Jet plow embedment would allow for simultaneous plowing and cable-laying to minimize impacts. As a result of disturbances to sediment during trenching and pile driving, small benthic organisms would be stirred up and prey fish may be attracted to the area to forage. This in turn could attract roseate terns to forage.

Scour protection at the base of monopiles will either be rock armor or scour mats. The rock or scour mats and the monopiles would increase the available surface area and provide substrate for the colonization of benthic invertebrates and habitat for prey fish. Fish may concentrate around turbine foundations similar to how invertebrates cluster around oil platforms (Vella, 2002 *as cited by* Jarvis, 2005). Habitat with more ‘physical heterogeneity’ can result in greater fish abundance (Jenkins *et al.*, 1997 and Charbonnel *et al*., 2002 *as cited by* Gill, 2005). The underwater structures could create a localized ‘artificial reef effect’, providing foraging habitat for terns. Wide spacing of turbines (0.34 to 0.54 nautical miles [0.63 to 1.0 km] apart) would allow for tern foraging between turbines (see section Risk of Collision below).

The boundary of the proposed action area would include approximately 25 square miles (6474 hectares) of WTGs and ESP (electrical service platform) foundations, and 5.89 acres (2.4 hectares) of transmission cable. The total area represents 11 percent of Nantucket Sound (Jarvis, 2005). However, the total area of seabed that would permanently be disturbed would be less than 1 percent of the total wind farm area: including approximately 1 acre (0.4 hectares) for the 130 turbines, 100 by 200 ft (30.5 to 61 m) for the ESP platform, and over 45 acres (18 hectare) for rock scour protection (Jarvis, 2005). The additional amount of surface area (approximately 1,200 square feet [111 square meters] per tower would result in a minor addition to the substrate that is currently available. Due to the small amount of additional surface area in relation to the total proposed action area in Nantucket Sound, and the spacing between WTGs, the proposed structures are not expected to have a significant affect on the benthic community, the presence of prey fish, or foraging terns. However, the additional substrate would be oriented vertically in the water column, and could result in a localized and minor increase in certain prey fish species. The increase in prey fish may ultimately attract tern species to the area to forage (see Section 5.1.1.2.3, Risk of Collision).

The available baseline survey data suggests that HSS is not a primary foraging location or traveling corridor for breeding or staging roseate terns; rather, during surveys the majority of terns were observed over shallow waters close to the shorelines of Cape Cod, Martha's Vineyard, and Nantucket (Figure BA-12). Given the small footprint of the actual development area, discountable habitat loss is anticipated during the proposed action's construction and operation activities. Impacts associated with displacement of prey fish during construction are anticipated to be discountable and temporary. The natural benthic substrate and prey fish communities would be maintained to the extent practicable after a short recovery period; therefore, adverse impacts associated with loss of habitat or modification are not anticipated. Changes to the under water substrate may result in increased foraging habitat for roseate terns. The impacts associated with decommissioning are anticipated to be similar to or less than construction activities because pile driving would not be required (Jarvis, 2005).

5.3.1.2.2 WTG Presence and Rotor Movement

The presence of wind turbines and the spinning of the blades could present barriers to the flight paths of birds and could potentially affect or restrict access to breeding, staging, or foraging habitat. Drewitt and Langston (2006) hypothesize that wind farms could potentially lead to significant impacts if it were to occur in an area of high use by birds. Barriers can result in increases in energy expenditure if birds are forced to travel greater distances while accessing foraging habitats or while undertaking migration movements. However, there are no known situations where a wind farm has created a 'barrier effect' resulting in an avian population level impact (Drewitt and Langston, 2006) although this conclusion is based in a few available studies.

Terns have been observed to continue to use WTG areas at existing offshore and near-shore facilities during both migration and breeding periods and to nest nearby (see below). Post-construction radar studies during migration at the Nysted and Horns Rev wind farms in Denmark indicate that, although the greatest levels of movement occurred outside of the wind farms, terns continued to migrate through the wind farm areas (Petersen *et al.,* 2006). The facility is located 8.7 mile (14 km) offshore and is comprised of 80 turbines with a rotor zone of 98 to 360 ft (30 to 110 m). The turbines are spaced 1,640 ft (500 m) apart, half the distance of the proposed action's turbines. Visual data collected at the Nysted and Horns Rev facility indicate that the majority of terns generally avoided the direct wind farm area but increased their use of the 1.2 mile (2 km) zone surrounding the facility (Petersen *et al.,* 2006). Terns were observed foraging at the outer edges of the facility around turbine structures. Small flocks flew into the farm, but then exited the area after passing through the second row of turbines (Petersen *et al.,* 2006). Sandwich terns (*S. sandvicensis*) entered the wind farm between two turbines more frequently when one or both of the turbines were not active (Petersen *et al*., 2006). Common and arctic terns (*S. paradisaea*), observed flying in the vicinity of turbines at a facility in Kalmar Sound, Sweden, flew between turbines or right next to the turbines instead of veering off in wide curves as waterfowl species were observed to do (Pettersson 2005). The Kalmar facility is located 1.9 to 7.8 mile (3 to 12.5 km) from the shore with 12 turbines spread out over two locations positioned 20 to 30 km apart. The rotor zone is 115 to 328 ft (35 to 100 m) above the water surface. The facility is located along a major migration corridor for water birds. Most birds were observed making slight alterations to their flight paths while traveling past turbines to avoid approaching individual turbines. It was estimated that the presence of the turbines resulted in a minor increase (0.2 to 0.5 percent) to the overall distance traveled by most birds during migration (Pettersson, 2005).

A post-construction study at the Zeebrugge wind farm in Belgium investigated the level of the proposed action's disturbance on nesting terns. An artificial peninsula, created to provide nesting habitat for common (*S. hirundo*), sandwich (*S. sandvicensis*), and little (*S. albifrons*) terns, was built adjacent to 25 existing small to medium-sized turbines on a breakwater. In 2004, terns nested as close as 98 ft (30 m) from the turbines, while the majority of nests were situated 328 ft (100 m) or further from the turbines (Everaert and Stienen, 2006). In 2005, terns nested as close as 164 ft (50 m) from the turbines. The greater distance between nests and turbines in 2005 was presumed to be a result of the distribution of vegetative growth on the peninsula and not due to the operation of the turbines themselves (Everaert and Stienen, 2006). While terns traveled to and from the colony past the turbines, many made no apparent changes in their flight paths. The terns that exhibited a reaction to the turbines made slight changes in their flight paths to fly between turbines (Everaert, 2004). The turbines did not present barriers to the flight paths of terns and observations suggest the presence of turbines resulted in minimal increases in energy expenditure for the terns. It was concluded that the presence of the turbines represented little disturbance to the activity of breeding terns (however, the action resulted in high numbers of collisions due to the facility's location in proximity to the colony, discussed in the following section, Risk of Collision).

A more local tern-turbine interaction study was conducted during 2006 and 2007 at the Massachusetts Maritime Academy (MMA) campus turbine. The MMA turbine has a maximum height of 74 m (243 ft) (85 to 243 ft [26 to 74 m] rotor zone) and is located at the western entrance of the Cape Cod Canal. The turbine is situated 328 ft (100 m) from the water's edge on a landmass adjacent to an important common and roseate tern foraging location, the Mashnee Flats Shoal located 5.3 miles (9 km) from one of the largest roseate tern breeding colonies, Bird Island. The terns forage in the waters on either side of the peninsula that the MMA turbine is located on. Visual surveys and mortality searches were conducted from April 24 to November 30, 2006, and from April 15 to November 30, 2007 covering the breeding, staging, and fall migration periods (See Section 5.3.2 Risk of Collision for information regarding mortality searches). Visual surveys were conducted from 5:30 am to 9:30 pm (0530 – 2130). In both 2006 and 2007, terns were most abundant in the turbine airspace (within 164 ft [50 m] of turbine tower, rotor, and blades) during the "chick-rearing period" (June 19 – August 6), particularly in 2007, and least abundant during the "nesting period" (April 24-June 18) and during the "post-breeding period" (August 6 – September 30). For both study years combined, there were a total of 8 identified roseate terns observed in the turbine airspace. The roseate terns observed in the turbine airspace always flew below the rotor-swept zone, between 8 and 21 m above ground. The study demonstrated that terns continued to use the 50 m [164 ft] airspace around the turbine while traveling between foraging locations (Vlietstra, 2007). However, the operating rotors and spinning blades were observed to deter terns from flying directly within the rotor zone of the turbine when the rotor velocity was greater than 1 rotation per minute (rpm). Under these conditions, terns were found to be 4 to 5 times less abundant in the turbine airspace in 2006. When the rotor was operating, terns usually flew below or above the rotor, and when the rotor was at rest, terns flew through the airspace at a range of heights, including within the rotor zone

Vlietstra, 2008). It was hypothesized that the terns visually and acoustically detected the spinning blades when the rotor was operating (Vlietstra, 2007). Despite the turbine's location in between foraging locations, terns continued to use the area. It appears that terns access to foraging habitat in the waters on either side of the peninsula was not restricted.

As terns are known to travel and forage around other man-made structures, including lighthouses, bridges, and wind turbines, it is likely that roseate terns would continue to use the proposed action area after construction of the proposed action. Although the majority of terns are expected to avoid the direct WTG rotor swept area (refer to the following section, Risk of Collision, for detailed information of avoidance behavior), it is anticipated that terns would continue to travel and forage in the vicinity of the proposed action. Also, because the turbines are widely spaced (0.34 to 0.54 NM [0.63 to 1.0 km] apart), it is anticipated that most terns would occur between turbines while traveling at heights within the rotor swept zone. The space between the turbines at Zeebrugge was markedly less than this (90 to 120 m [27.45 to 36.6 ft]) and the terns at that facility continued to regularly travel through the turbines. The presence of WTGs and spinning blades is anticipated to result in discountable impacts to roseate terns (see Collision Risk for different impacts associated with collision mortality).

5.3.1.2.3 Risk of Collision

The potential exists for roseate terns to collide with WTG structures, including the blades and tubular towers during the breeding, staging, and migration periods when any individual from the northeastern population could occur in the vicinity of the proposed action area. The results of available terrestrial mortality studies conducted in primarily terrestrial environments for general avian species indicate that the majority of collisions with man-made structures take place at night during periods of inclement weather (Kerlinger, 2000). There is limited mortality data available regarding the conditions of greatest risk of collision at offshore wind sites; however Huppop *et al.* (2006) determined that risk of collision with man-made structures located offshore is elevated during rain and fog.

Roseate terns may be at risk of collision while foraging, commuting, or conducting courtship aerial flights in the vicinity of WTGs during periods of good and limited visibility. Terns that fly within the rotor zone of the proposed turbines (75.5 to 440 ft [23 to 134 m]) during periods of low visibility may be at greatest risk of collision.

Collision Risk during Periods of Good Visibility

Outside of migration, terns are mainly active during the day; except at dusk and dawn when they have been observed to depart or arrive at roosting locations (Trull *et al.,* 1999; Hays *et al.,* 1999), and are sometimes active at night (see Collision Risk during Periods of Low Visibility). During daytime periods of good visibility, there is generally a low risk of roseate tern collision with the proposed WTG structures based on the observed avoidance of some man-made structures, including turbines (see below). However, it is possible that if terns were to use the WTG and ESP platforms (assuming that the perch deterrent devices as described in Section 8 are faulty), they may be at greater risk of collision even during periods of good visibility if they initiate courtship rituals from these structures (MDFW, personal communication)

Results of post-construction studies at existing European facilities suggest offshore wind farms, when properly sited, do not impose adverse impacts to local tern populations. Studies conducted at the wind farms in Sweden and Denmark showed continued tern use of turbine areas after development, as well as collision avoidance behaviors when terns approached individual turbines (Peterson *et al*., 2006; Pettersson, 2005).

The study conducted in 2007 and 2006 at the MMA turbine, near the Cape Cod Canal in Buzzards Bay, indicated continued use of the area by roseate terns and avoidance of the rotor zone when the turbine was operating at greater than 1 rpm (Vlietstra, 2007). When the rpm was greater than 1, terns were 4 to 5 times less abundant in the 50 m (164 ft) airspace surrounding the turbine blades in 2006. During 2006, tern passage rates were evaluated in relation to rotor velocity: when the rotor was operating, 6 percent of all terns (3 of 51) in the turbine airspace flew at rotor-swept altitudes, whereas 16 percent (33 of 203) flew within the rotor-swept altitudes when the rotor was shut-down (Vlietstra, 2008). For the 8 total roseate terns observed in 2006 and 2007, flight altitudes were consistently below the rotor zone, between 8 and 21 m above ground (Vlietstra, 2008). For those terns observed passing through the rotor-swept zone when the turbine was operating, there were three sitings of common terns that passed through unscathed when the rotor velocity was 3.0 rpm. It was hypothesized that the terns visually and acoustically detected the spinning blades when the rotor was operating (Vlietstra, 2007; 2008). In the MMA study area, tern observations most frequently occurred during the morning hours (5:30 am to 11 am), followed by midday (11 am to 4 pm), and then evening (4 pm to 9:30 pm). Roseate terns specifically were most often observed during the midday hours (Vlietstra, 2008); however, time of day did not appear to influence the likelihood of terns entering the rotor-swept zone – there was no relationship between the presence of roseate terns in the turbine airspace and time of day (Vlietstra, 2008) (see Collision Risk during Periods of Low Visibility for discussion of observations during fog conditions). Mortality surveys at the MMA turbine indicated no tern fatalities in 2006 or 2007. There were 5 total birds found during the mortality searches in both years combined, three of these birds (a laughing gull [*Larus atricilla*], osprey [*Pandion haliaetus*], and a great black-backed gull [*Larus marinus*]) were presumed to have collided with the turbine (Vlietstra, 2008).

There is a new wind farm located in Pubnico Nova Scotia (17 turbines) that is located 2.4 miles (4 km) from the largest population of roseate terns in Canada. Mortality surveys and avian impact assessments are currently being conducted. Little information is available regarding methods or results at the time of this consultation; however, there has been no observed tern mortality and terns have rarely been observed during coastal monitoring surveys (C. Matkovich, pers. comm.).

Poorly sited facilities can result in high collision rates of terns. A mortality study conducted at the Zeebrugge, Belgium facility reported notably high tern collision mortality. Everaert and Stienen (2006) concluded that wind turbines should not be placed in the frequent flight paths of terns, nor should artificial nesting habitat be created adjacent to turbines as the collision mortality observed at the Zeebrugge facility was determined to have an adverse impact on a breeding population of terns. At this facility, nesting habitat was enhanced on the eastern port side of the breakwater next to a string of 25 small to medium sized turbines (10 200 kW, 12 400 kW, and 3 600 kW turbines). Since operation of the facility, terns have nested as close as 98 ft (30 m) from the towers. Between 2001 and 2003, there were 20 total tern fatalities found at the site. However, in 2004 alone, the number of tern fatalities was more than double the number of fatalities found in the three previous years combined. There was a correlation between increases in the number of breeding pairs and increases in collision mortality, and it was presumed that an increased number of foraging flights since 2004 resulted in the observed increase in collision fatalities in 2004 and 2005 (Evareart and Stienen, 2006). In 2004 and 2005 respectively, there were 1,832 and 1,475 breeding pairs of common tern; 4,067 and 2,538 breeding pairs of sandwich tern (*Sterna sandvicensis*); and 138 and 11 breeding pairs of little tern (*Sterna albifrons*) at the colony adjacent to the turbines. There were 50 and 52 total terns found during mortality searches at the 25 turbines combined in 2004 and 2005, respectively. In 2004, little terns represented 6 percent, sandwich terns represented 24 percent, and common terns represented 70 percent of the found tern fatalities. In 2005, little terns accounted for 2 percent, sandwich terns 20 percent, and common terns accounted for 82 percent of the found tern fatalities. The estimates of total tern mortality in 2004 and 2005 were 168.3 and 160.9.

In 2004 and 2005, most of the tern fatalities were found in May through July, when terns preformed the majority of their movements between the breeding colony and their feeding grounds at sea (Evareart and Stienen, 2006). All fatalities found were adults (Everaert and Stienen, 2006). The 4 turbines on the sea-directed side of the breakwater (with a rotor-swept zone of 52.5 to 164 ft [16 to 50 m]) are oriented perpendicular to the flight route of terns crossing the eastern port breakwater while traveling between foraging locations and the colony; these turbines accounted for 90 percent and 92 percent of all tern fatalities in 2004 and 2005, respectively.

In June 2004 and June 2005, during two 17-hour survey days the number of terns crossing the turbines at the eastern port breakwater was counted. It was found that sandwich terns preformed substantially more crossings than common terns: in 2004 and 2005, the observers counted 10,263 and 4,228 common tern crossings, and 15,237 and 12,334 sandwich tern crossings. However, more common tern fatalities were found during fatality searches and common terns were found to have a higher probability of collision: the collision probability for common terns was estimated at 0.110 to 0.118 percent of flights in the rotor-zone, and 0.007 to 0.030 percent of all flights; the collision probability of sandwich terns was estimated at 0.046 to 0.088 percent of flights in the rotor-zone, and 0.005 to 0.006 percent of all flights (Everaert and Stienen, 2006). If the risk of collision was simply dependent on the number of crossings and the overall time terns are exposed to the turbines, one would expect sandwich terns to have exhibited a greater probability of collision than common terns based on the substantially greater number of crossings of sandwich terns observed and the greater abundance of sandwich tern breeding pairs at the site. However, the authors indicated that, “[t]he lower collision probability for sandwich terns may be due to the fact that sandwich terns mainly flew in a straight line toward the feeding grounds and back, whereas common terns had more irregular flight paths and preformed more circling movements around the colony” (See below for additional discussion of increased risk of collision of roseate terns in the proposed action area due to the potential for courtship flight behaviors).

Collision probability at the Zeebrugge facility was believed to be influenced by flight behaviors and flight height, but observed increases in collision fatalities were mainly attributed to the increased number of crossings of the turbines after the number of breeding pairs at the tern colony increased in 2004. In relation to collision risk at HSS, the results of the Zeebrugge study indicate that an increased number of crossings could result in increased collision fatalities. More information regarding roseate tern movement patterns through HSS is required to better assess collision risk. If a tern travels across HSS to access foraging habitat, or a breeding or roosting site, on its return flight it may not travel along a similar flight trajectory or even cross HSS due to the effects of wind drift. In 1990 and 1991, 65 count surveys were conducted at Bird Island, to assess the return rates of foraging roseate terns (Heinemann, 1992). Nine radial sectors were established, each 30-50 degrees, around the island. The observers counted terns as they commuted to foraging locations. The surveys documented a substantial number of returns occurring in the sectors adjacent to the sectors in which the terns were foraging: it was presumed that the wind had an effect on the terns' flight paths (Heinemann, 1992). The results of this study indicate that wind drift plays a role in the flight paths of roseate terns commuting between foraging locations and the colony. In relation to crossings of the project area, if a roseate tern crosses HSS while commuting toward a foraging location, it may not cross HSS on its return flight, due to the effects of wind.

The results of the Zeebrugge study indicate that collision probability is not simply a function of the number of crossings of the turbines or the overall time spent in the rotor-zone; in addition, specific flight behaviors may increase the probability of collision. The primary flight behavior expected of roseate terns in the proposed action area is relatively direct paths (with some influence of wind drift on the direction terns travel) to and from breeding, staging, or foraging locations. However, the additional substrate resulting from the proposed action (as described in Section 5.3.1.2.1) would be oriented vertically in the water column, and could result in a localized and minor increase in certain prey fish species. The increase in prey fish may ultimately attract tern species to the area to forage. A potential increase in the abundance of foraging terns may increase the risk of collision. Roseate terns are known to forage at low heights of 3.3 to 39.4 ft (1 to 12 m) (Gochfeld *et al.*, 1998); therefore, when foraging at low altitudes terns would be expected to be at low risk of collision with the WTG blades as they would remain below the proposed rotor zone. Nisbet (2005) suggests that "Terns are at little risk of collision with turbine rotors when they are foraging, because they are then usually within 10-15 m [3.1–4.6 ft] of the sea surface. The main risk of collision is when they are commuting, when they sometimes fly higher." Terns are expected to have a high avoidance of collisions with stationary monopoles during periods of good visibility, given their known flight maneuverability around artificial structures while traveling and foraging.

A flight behavior that could put roseate terns at a greater risk of collision with the proposed WTGs is aerial courtship displays which typically involve flights at heights of 98 to 980 ft (30 to 300 m) (Gochfeld *et al.*, 1998). However, provided that the perch deterrent devices and monitoring for adaptive management (as described in Section 8) are effective in preventing opportunistic use of the WTG and ESP structures, terns would not be expected to launch these high risk flight behaviors in the vicinity of HSS. However, Nisbet (2005) notes that the ESP platform would be difficult to bird-proof without preventing helicopters from landing on the platform as well. If the perch deterrent devices are faulty, it is possible that roseate terns may initiate courtship flights from the ESP and WTG structures which would result in an increased risk of collision. Some courtship behaviors have been observed at the edge of colonies or at resting areas far from the colonies (Gochfeld *et al*., 1998); and observations of courtship aerial displays have been made at foraging locations (Nisbet, pers. comm.; C. Mostello, pers. comm.; M. Amaral, pers. comm.). These displays have infrequently been seen at foraging locations but this behavior has not been studied for terns foraging offshore; these flights are not usually initiated by a bird with a fish, so they could happen at HSS (M. Amaral, pers. comm.). Observations made at Bird Island indicate that high flights are conducted throughout the season and may serve the purpose of mate selection for the following year (Gochfeld *et al.,* 1998). The approach of vessels or helicopters associated with the proposed action's construction and maintenance or other unassociated vessels or aircraft could cause terns to quickly depart the proposed action area. Fleeing behavior could increase the risk of roseate tern collisions with the WTG structures. If the perch deterrent devices are faulty, Nisbet (2005) notes that the wires and fences used on the ESP and WTG platform in an effort to deter birds may pose a risk to birds fleeing the structures. The risk of collision is greatest for terns traveling through the blade-swept zone of the proposed WTGs.

As would be expected, the results of the Zeebrugge study indicate that those terns flying within the rotor zone have a greater probability of collision. The potential exists for roseate terns to occur at heights within the rotor-zone of the proposed action while traveling, especially if traveling downwind. Particularly in the breeding season, roseate terns are under intense energy demands as they access foraging locations as far as 16 to 19 miles (25 to 30 km) from colony sites. If a tern were undertaking such a movement across HSS it can be assumed that it would travel in the most energy efficient manner. Therefore, a tern's height of flight would depend largely on wind speed and direction. A boat survey conducted from August 28 to August 31, 2006, documented a total of 966 commuting terns; 110 of 958 non-foraging terns were flying within the rotor-zone; of 177 terns flying downwind, 70 terns (40 percent) were flying within the rotor-zone (Report No. BA-1; Nisbet, personal communication). It was found that flight altitude decreased for terns flying upwind as wind speed increased (Report No. BA-1). The authors described the costs and benefits for terns flying in different wind speeds and different wind directions: birds flying upwind can decrease travel costs by not climbing and by flying in weaker headwinds close to the water's surface. Benefits of flying high downwind include stronger tailwinds (Report No. BA-1). Terns may conserve energy by taking advantage of stronger tailwinds at higher flight altitudes. If traveling across HSS with following winds, terns may travel within or above the rotor-zone. In order to further examine correlations between tern flight heights and wind speed, the authors of this BA used data collected during the periods when terns were present in the region in 2002 through 2004. Flight height data for 'flying' and 'commuting' terns (all tern species) collected during the Applicant's and MAS' aerial surveys were correlated to wind speed data, where possible. There were limited data for which wind speed, wind direction, and flight direction were available during the 2002 to 2004 surveys; therefore, this analysis was limited to relationships between wind speed and flight height. For the 14 survey dates included (when both flight height and wind speed data were available), wind speeds varied from 1 to 17 knots (average 7.1 knots). The analysis included observations of 1,152 individual terns. For this data set, the correlation coefficient, r, was 0.02, and the coefficient of variation (r2) was 0.0005, both indicating that there was little to no relationship between these two variables. The average wind speed for this dataset was 7 knots and the average wind speed for the Applicant's August 2006 surveys was comparable at 6 knots. Determining the relationship between wind speed and flight heights in a variety of wind speeds would require further investigation.

If making shorter, more localized flights in an effort to forage in HSS, roseate terns would be expected to occur at flight heights at or below their maximum foraging height of 39.4 ft (12 m). Nisbet (2005) suggests that "Terns are at little risk of collision with turbine rotors when they are foraging, because they are then usually within 10-15 m [3.1–4.6 ft] of the sea surface. The main risk of collision is when they are commuting, when they sometimes fly higher." It is expected that the majority of roseate terns would fly below the rotor zone when commuting with a headwind. When commuting into a strong headwind, other species of tern have been observed to fly closer to the surface of the waves (Alerstam, 1985). As the predominant wind direction is from the southwest during the summer and the average annual wind speed is 19.75 mph (8.8 m/s) in Nantucket Sound, it can be assumed that when roseate terns are traveling in a south, southwest, or westerly direction across HSS, they would regularly occur at heights below the proposed rotor zone. However, if traveling in following winds while commuting, terns may fly at higher altitudes. Nisbet (2007) hypothesizes that most terns or all terns flying with a following wind (± 45° of the birds' heading) are likely to fly at rotor height through HSS. There are available data which suggest terns will fly higher in following winds. If traveling across HSS with following winds, terns may travel within or above the rotor-zone.

There is the potential that additional mortality or injury could result from birds not actually colliding with the turbines, but getting caught in the turbulence behind rotors (Winkelman, 1994). Winkelman's 1992 study suggests that approximately 20 percent of avian mortality found at the shore-based Oosterbierum wind farm in the Netherlands was caused by such turbulence 'strikes', however, there are no other studies that have reported observations of this phenomenon for birds (Desholm, 2006). Turbulence effects may also increase avian avoidance of turbines. Daytime visual surveys, radar, and nocturnal surveys with a thermal image intensifier suggested that birds flying into a headwind were more likely to react to turbines perhaps because they approached the rotor wake before reaching the rotor (Winkelman, 1994). The MMA turbine study suggests that birds can, in addition to visually detecting and avoiding turbines, detect the 'whooshing' sound that rotors create (Vliestra, 2007). Potential turbulence effects to birds would depend on the wind speed and direction, and the direction from which a bird approaches a turbine. However, further studies are required to determine the level of impact rotor turbulence poses to terns.

Turbine Avoidance Behavior during Periods of Good Visibility

Terns, during periods of good visibility, are expected to regularly avoid collisions with the proposed turbines based on observations of tern behavior at existing facilities (Vlietstra, 2007; 2008; Peterson *et al*., 2006; Pettersson, 2005). Roseate terns are agile fliers and they would be expected to visually detect and avoid the moving blades and stationary towers of the proposed turbines during periods of good visibility when foraging or commuting; however, it is possible that terns may have reduced avoidance of the proposed turbines if initiating courtship flights from the WTG structures. Modern turbines are more avoidable as they have only three, relatively slow rotating blades. Roseate terns regularly avoid collisions with other man-made structures including moving vessels, piers, bridges, and lighthouses, as well as wind turbines (see Collision Risk during Periods of Low Visibility for discussion of risk of collision with man-made structures when visibility is restricted).

Hatch and Brault (2007) (Report No. 5.3.2-1) used the Bolker model to estimate the number of turbines encountered during a single crossing of the proposed action area to assess the potential for collisions. The proposed turbines would be spaced 0.34 to 0.56 NM (0.63 to 1.0 km) apart and would be oriented in a single direction during a single tern crossing. Therefore, assuming terns travel in straight paths from all angles through the proposed action area at flight heights distributed evenly through the rotor zone, the estimated number of turbine encounters during a single crossing at rotor height is 0.43. Under the same assumptions, the estimated number of monopoles encountered during a single crossing is 0.04. These numbers are likely accurate estimates of the number of potential roseate tern encounters with turbine structures because the majority of terns in HSS would be expected to move through the proposed action area along straight flight paths. The potential for collisions with WTG structures is influenced by wind direction and its influences on tern flight behavior. The authors suggest that birds flying downwind in the rotor zone are at a decreased risk of collision because of the rapid groundspeed at which they would pass through the blade area. Alternatively, the risk of collision is greater when birds pass turbines while traveling into a strong headwind because of the slow groundspeed at which they travel through the blades. However, terns are less likely to be flying within the rotor zone while traveling into a strong headwind as they tend to fly closer to the water surface under high winds (see following section, Collision Risk Modeling). Because monopoles are stationary and do not have moving parts, terns are expected to avoid collisions with these structures except during the most severe weather conditions, when the activity of terns in HSS is expected to be very low. The podolsky model, however, assumes risk of collision with stationary parts during all conditions. Additionally, terns have been observed to avoid approaching individual turbines at other facilities, by making slight alterations to their flight paths when passing turbines (Pettersson, 2005, Petersen *et al*., 2006, Everaert and Stienen, 2006).

Hatch and Brault (2007) Report No. 5.3.2-1) estimated a turbine avoidance rate for roseate terns traveling through the HSS proposed action area, based on a rate calculated for common, sandwich, and little terns at the Zeebrugge, Belgium facility (91 percent turbine avoidance). The avoidance rate observed at the Belgium facility was based on common tern observations in the vicinity of a nesting colony, where common tern flight paths were more frequently circular and irregular than the typically straight and direct paths of sandwich terns (Everaert and Stienen, 2006). Since roseate terns are smaller and faster flying than common terns and because the proposed rotor zone is above the majority of flight heights observed in HSS, Hatch and Brault used an estimated range of avoidance rates for roseate terns in HSS, 95.3 percent and 98.3 percent. ESS (see Appendix A to the BA) indicated that roseate terns are intermediate in flight characteristics between common and sandwich terns, but only during flights occurring under the same conditions. The values selected by Hatch and Brault (2007) to estimate roseate tern turbine avoidance rates were chosen with the assumption that roseate terns would not fly like common terns do near the nesting colony at the Zeebrugge windfarm. ESS (see Appendix A to the BA) notes that the common tern collision rates observed at the Zeebrugge wind farm should be interpreted with caution as, because they apply to terns at a nesting colony, they are misleading. Therefore, ESS (see Appendix A to the BA) indicates that it is reasonable to assume that roseate terns at HSS would exhibit flight characteristic similar to those reported by Everaert and Stienen (2007) (collision probability of 0.046–0.088 percent for flights at rotor height and 0.005–0.006 percent for all flights).

The tern avoidance rates estimated by Hatch and Brault (2007) are consistent with rates calculated at a few existing wind farms in the U.S. where mainly geese and raptor species were estimated to have avoidance rates greater than 95 percent. Fernley *et al.* (2006) calculated the avoidance rates for geese at four operating land-based wind farms in the U.S. using the Band Collision Risk Model. The avoidance rates calculated at the four facilities ranged from 99.82 percent to 100 percent despite high usage by geese at these wind farm sites. Whitfield and Madders (2006) used the Band Collision Risk Model to estimate the avoidance rate of hen harriers (*Circus cyaneus*) at eight wind farms in the U.S.: estimates were 100 percent at 6 sites, 99.8 percent at 1 site, and 93.2 percent at 1 site. Other avoidance rates reported include: 99.62 percent mainly for gull species at Blyth Harbor in Northeast England, 99.5 percent for golden eagle (*Aquila chrysaetos*) at a U.S. facility, and 99.98 percent for passerines at the Oosterbierum wind farm in the Netherlands (Chamberlain *et al*., 2006). There are, however, limitations to the Band Collision Risk Model as it does not account for differences among bird activities and behaviors under a range of conditions, and because avoidance rates exhibited by a range of species are understudied (Chamberlain *et al.,* 2006). Chamberlain *et al*. (2006) had concerns with applying an avoidance rate that was calculated for a different species because inaccuracies in avoidance rate calculations can have magnified effects on estimated mortality rates.

As was observed at the Zeebrugge facility, an increased number of flights past turbines may result in an increased risk of collision due to more exposure to towers and spinning blades. If tern use of HSS increases due to changes in breeding or roosting locations, or due to increases in prey fish abundance around the WTG underwater structures, the risk of collision may increase. Courtship flights in the vicinity of WTGs could increase the risk of collision as well. There will be an adaptive management monitoring plan for the anti-perch scheme (as described in Section 8) to prevent perching and the initiation of high flights from the WTG and ESP platforms. Actively foraging terns would be expected to remain below the rotor-zone and would be at decreased risk of collision with spinning blades. Because roseate tern turbine avoidance rates during periods of good visibility are expected to be high, risk of collision during periods of daytime fair weather are anticipated to be low. Roseate terns may fly higher in following winds and may occur within the rotor zone while commuting; however, terns may be at decreased risk of collision with the spinning blades if flying with following winds because of the shorter length of time spent in the rotor-zone due to a higher ground speed (Report No. 5.3.2-1); and because during the day, terns are expected to visually detect turbines. Although flights into headwinds at rotor height would be more dangerous due to a greater amount of time spent in the rotor-zone while passing. Terns are expected to fly closer to the water's surface when flying into headwinds to avoid excessive energy expenditure, and would therefore not be expected to fly in the rotor-zone during such conditions: only 1 of 110 terns flying into a headwind during the August 2006 surveys flew at the height of the rotor-zone *(see Results of Surveys and Available Information).* Collision risk associated with periods of good visibility is expected to be low; however, the loss of even a single individual roseate tern represents a moderate adverse impact.

Collision Risk during Periods of Low Visibility

There is the potential for roseate tern crossings of HSS during periods of fog or rain, during nighttime movements, and during crepuscular commutes to and from nocturnal roosts (particularly during the staging period in August and September) when visibility is decreased and the risk of collision is elevated. Nisbet (personal communication) noted that a study conducted by Winkelman in 1992 with thermal image intensifiers found that 1 of 40 (2.5 percent) of nocturnally migrating birds (not terns) passing through the rotor-zone of a land-based wind farm collided with turbines. Due to the difficulties of surveying during these conditions, there is no information about roseate tern occurrence and behavior in HSS at night or during other periods of decreased visibility. Therefore, the assessment of risk of collision during these conditions in this section must rely heavily on data collected on tern and general bird behavior at existing wind turbines located onshore, near-shore, and offshore.

During the breeding and staging periods, terns arrive at roosting sites around sunset and continue to arrive after dark (Trull *et al.,* 1999). Terns are presumed to depart staging grounds before sunrise to travel to foraging locations. While making daily movements to and from breeding habitat, some roseate terns have been observed traveling overland across Cape Cod and some may pass over waters in Nantucket Sound (RTRT, 2007). It is possible that terns may cross HSS during commuting flights to and from nocturnal roosts during post-breeding staging in August and September. Observations made in August 2002 in the southern part of the shoals study area documented terns flying after sunset toward Ferdando's Fetch. Terns will also fly at night if disturbed by predators at the colony site but as HSS is not located near breeding colonies, it is unlikely that these flights would occur over HSS. J. Hatch (as noted in Report No. 5.3.2-1) and Nisbet (unpubl. obs.) have seen and heard mixed-species flocks of terns arriving at South Beach after sunset, descending from heights of 37-60 m (or higher). Nisbet (2005) notes that project area at HSS does not lie directly between the roosting area at South Beach and the daytime resting areas as described by Trull *et al.,* 1999; however, the parts of Martha's Vineyard from which terns would fly through the project area on a direct course to South Beach have not been surveyed. It is unknown whether migratory flights may result in nighttime crossings over the waters of Nantucket Sound.

Roseate terns disperse to their wintering grounds during August and September and return to breeding locations from late-April to mid-May. Some terns depart for wintering grounds during the day but it is likely that terns also depart in the evening. There is little data available on roseate tern nighttime migration; however, other species of tern are known to travel extensively at night (Alerstam, 1985). Additionally, observations have been made of mixed flocks of terns departing staging grounds in Nantucket Sound around sunset (Report No. BA-1). On August 29, 2006, around sunset, approximately one mile northwest of South Monomoy Island, a total of 75 terns were observed soaring to heights of 427 ft (130 m), the highest birds disappeared into the clouds (Report No. BA-1). It was presumed that the terns were departing South Beach and preparing to migrate. However, their flight direction indicated that they would not cross the proposed action area. Although there are no known staging areas that would funnel terns over HSS, in varying wind conditions, the potential exists that roseate terns could cross HSS while departing staging grounds or when arriving at breeding areas in the spring. If migrating terns were to occur over HSS, the risk of collision would be dependent upon the flight height of the migrants and their ability to detect and avoid the WTGs.

Terns have been observed at heights well above the rotor zone when making migratory movements. There have been observations of what were assumed to be both roseate and common terns departing South Beach in the fall around sunset, apparently heading toward their wintering grounds, and quickly gaining altitudes of hundreds of meters (Veit and Petersen, 1993). Other species of terns have been observed migrating at heights above 9,842 ft (3,000 m) when migrating over land (Alerstam, 1985). It is likely that nighttime migration movements of terns traveling direct to the Gulf of Maine, if they were to cross HSS, would occur well above the rotor zone. The flight height, however, would be dependent on weather conditions. If terns were to depart in unfavorable conditions such as strong headwinds, their flight heights would likely be lower as other tern species have been observed flying close to the water's surface during strong headwinds (Alerstam, 1985). More data is required to assess potential roseate tern migratory behavior in HSS during a variety of weather conditions.

Studies have demonstrated that steady burning FAA obstruction lighting, (Gehring and Kerlinger 2007) and some other types of lighting, on tall structures can cause collisions by attracting or disorienting night migrating birds, especially during periods of fog, rain, or low cloud ceiling (Huppop *et al*., 2006). The birds involved in collisions with a lit platform located offshore were primarily night migrating songbirds and a few other species, including one dunlin (*Calidris alpina*) and four large gulls (Huppop *et al*., 2006). Terns are rarities among reported collisions at 47 mainly land-based and some coastal communication towers in the U.S. that are lit and are typically over 200 ft (61 m), with one sooty and one common tern reported at the 47 towers as of 2000; gulls, terns, and petrels represented 2 percent of fatalities reported at these towers (Shire *et al*., 2000). Although passerine species are known to be attracted to the refracted lighting at "offshore obstacles" during periods of fog or rain (Huppop *et al*., 2006), there is no data available that suggests terns are attracted to refracted lighting during these conditions.

Natural sources of nighttime lighting (i.e., moonlight or starlight) may decrease the risk of tern collisions if their movements result in nighttime crossings of the proposed action area. The lighting mounted on nacelles may help terns detect the presence of the WTGs (not necessarily the blades) and may facilitate avoidance of the WTG area. At the Nysted and Horns Rev wind farm in Denmark, wind turbines positioned at the outer edge of the wind farm are equipped with two medium intensity flashing red lights on the top of the nacelles. The lights operate at a frequency of 20 to 60 fpm (Peterson *et al.,* 2006). Radar observations suggest that birds approached the turbines at closer distances at night than during the day, and that more birds entered the wind farm at night than during the day; however, observations indicated avoidance behavior of the turbines by nighttime migrants. The typical distance at which an avoidance reaction occurred was 1,640 ft (500 m) from turbines at night and 1.9 mile (3 km) during the day (Peterson *et al.,* 2006). It may be that that migrating birds react later to the turbines at night due to decreased visibility, but are eventually able to detect the turbines due to lighting mounted on the nacelles or natural sources of night lighting. Another study conducted with vertically oriented radar suggests that migrating birds may also react to turbines by 'vertical deflection' at night instead of the linear avoidance primarily observed during the day (Blew *et al.,* 2006 *as cited by* Peterson *et al.,* 2006). Peterson *et al.* (2006) observed a substantial decrease in the volume of migrating waterbirds during weather periods of elevated collision risk. Fewer waterbirds migrated during periods of inclement weather (Peterson *et al.,* 2006).

Results of the MMA turbine visual surveys conducted from 5:30 am to 9:30 pm (0530–2100), indicate that during the "chick-rearing" period (when terns were found to be most abundant in the turbine airspace), terns were equally abundant in the wind turbine airspace during periods of poor visibility as they were during periods of unlimited visibility (Vlietstra, 2008). Passage rates were statistically similar among periods of poor (0.2-1.0 km), moderate (1.0-10.0 km), and unlimited visibility in the morning and midday hours (5:30 am to 4 pm [0530–1600]). During the evening hours 4:00 pm to 9:30 pm [1600-2100], terns were more abundant in the airspace when visibility was moderate than when visibility was poor or unlimited (Vlietstra, 2008). More terns were observed in the turbine airspace when visibility was only slightly reduced, than when conditions were poor. Vlietstra suggests that if terns were not able to see and avoid the turbine during fog, terns would to be more abundant in the turbine airspace during periods of poor visibility. Vlietstra hypothesized that there may be a few factors that influenced these findings: 1) terns in the turbine airspace may have been undetected by observers during poor conditions; or 2) the difference in tern occurrences in the turbine airspace during varying visibility conditions may be correlated to other behavioral or weather related factors that are unidentified. No information is currently available about the correlations between rotor velocity and visibility conditions, and between flight height and fog (Vlietstra, personal communication). In the absence of these correlations, it is difficult to draw relevance from this study to assessing risk to terns crossing HSS during periods of reduced visibility. However, two of Vlietstra's findings are important to consider from this study when considering risk of collision in the proposed action area: 1) terns were equally as abundant in the turbine space during periods of poor visibility due to fog and unlimited visibility, and, 2) there were no tern fatalities found during mortality searches. However, this is a near-shore site consisting of one turbine that is notably smaller than the number of turbines proposed for HSS. Tern turbine-interaction behavior at a near-shore turbine as opposed to an offshore wind farm may vary.

In Belgium, at the Zeebrugge facility, surveys with night vision goggles were conducted on two nights in June 2004 and July 2005. The surveys were conducted to assess nocturnal flights of terns. No terns were observed aloft in the study area (Evareart and Stienin, 2006) on those limited survey nights. The data collected provides the best available information to estimate tern avoidance rates under various conditions.

During the breeding season, terns would likely continue to forage during the day in most areas of the Sound during light rain and periods of moderately high surf. However, during extreme high surf and wind conditions, one may speculate that terns would forage most efficiently in sheltered bays or salt marshes than in more exposed areas like HSS; however, there have been no surveys conducted to investigate this behavior. Surveys targeting tern behavior in the proposed action area during these conditions would be beneficial to the assessment of collision risk. In order to reduce stress on the turbines during storms, turbines are shut-down and their blades are 'feathered' so that the blades will not rotate at their maximum speed… Turbine rotation would shut-down when wind speed exceeds 55 miles/hour (24.5 m/s). Because the blades would be rotating more slowly, birds may have less of a chance of encountering a spinning blade if flying through the rotor-zone depending on the direction from which birds encounter the rotor. Therefore, feathering may decrease the risk of collision with the blades. However, the risk of collision remains with stationary monopoles and blades that are not spinning.

Collision Risk Modeling

The following information provides detail on the methods and results from the Applicant's collision probability modeling. In addition, Appendix A includes a response to comments from a December 2007 review of this modeling approach. MMS asks the FWS to consider this section as well as Appendix A as it evaluates the best available information provided on collision risk modeling for this species.

Hatch and Brault (2007) (Report No. 5.3.2-1) used a geometric model to determine the number of potential roseate tern collisions with the proposed turbines based on estimated annual averages of the number of roseate tern crossings of the proposed action area (a "simple averages model"). The model inputs included an estimated number of terns traveling through HSS at rotor height, the potential number of turbine rotors encountered, tern flight speeds (obtained from available literature), the estimated length of time spent within the Project Area, and an estimated roseate tern collision probability. ESS (see Appendix A to the BA) produced a recalculation of this model in 2008 in order to include revised values for six of the parameters of the 2007 collision model run by Hatch and Brault. The fact that data surrounding both 2007 and 2008 model parameters were unavailable makes it impossible to render a decision regarding which model was more accurate; therefore, the 2008 recalculation is considered an alternative, rather than a revision of the original model. Due to uncertainty surrounding model inputs and the use of different estimates for model parameters, model results are variable. Therefore, the results of both the draft 2007 and 2008 collision models are described below.

For the 2007 model, Hatch and Brault (2007) calculated the estimated average number of roseate terns that occurred in HSS during the course of a year. This calculation was based on mean average tern observations, mean flight altitudes, behaviors (e.g., traveling verses foraging), and the estimated proportion of roseate terns from mixed flocks observed in HSS during MAS and Applicant aerial and boat surveys conducted in May, June, July, August, and September of 2002-2004. From that average number, the number of tern crossings per year was estimated. The authors estimated nearly 18,000 tern-equivalents in HSS per year (a tern-equivalent is one tern in the Project Area continuously for the duration of a day).

However, in order to address concerns that high flying terns may have been missed during the field surveys, thus causing Hatch and Brault's 2007 calculation for the number of tern-equivalents to have been based on an underestimation, ESS used a revised value in the 2008 recalculation for the number of terns in the Project Area (see Appendix A to the BA). ESS re-calculated an estimated number of roseate tern-equivalents in HSS per year and the number of roseate tern crossings of HSS per year. ESS (see Appendix A to the BA) acknowledges that common and roseate terns are difficult to distinguish visually and that it is easy to over-estimate the number of roseate terns in a mixed flock because their vocalizations are distinct and they tend to be more vocal than common terns near staging and roosting areas. Therefore, their conservative estimate of roseate tern-equivalents was based on data values of 3.2 percent and 10 percent roseate terns in mixed-flocks observed in HSS during the field surveys. These values are considered notably conservative, seeing as some studies suggest that the proportion of roseate terns within mixed flocks in areas of Cape Cod range from 11 to 33 percent (Trull *et al.*, 1999 *as cited by* Nisbet, 2007). Using the higher proportion of roseate terns among mixed flocks, the estimated number of roseate tern-equivalents in HSS per year is 1,773. The number of roseate tern crossings of the project area was estimated at 150,000.

The number of roseate tern crossings of HSS per year was conservatively estimated because the model assumes that traveling terns continue to cross the wind farm and are replaced by others as they exit the proposed action area during 12.5 daylight hours, during the time that they are present in Nantucket Sound. This period of daylight hours refers to the time roseate terns are potentially in the Project Area, not that of daily activity periods. As noted by Trull *et al.* (1999) and Hatch and Brault (2007), some terns are known to arrive at the South Beach roost after sunset, but the (limited) evidence available suggests that arrivals peak before sunset and decline rapidly thereafter (see Report No. BA-1). ESS (see Appendix A to the BA) notes that most terns leave foraging areas when it becomes too dark to hunt effectively; and the earliest departures from the roost or colony in the morning may occur before sunrise (but there is no data available regarding this behavior), and the deliveries of food to chicks at nests occur after sunrise. This suggests that commuting travels are restricted by low light conditions at foraging locations. Field surveys in May 2006 (stationary boat surveys) included 2 days when observations began less than 10 minutes after sunrise. The first terns were seen at 60 and 70 minutes after sunrise; on 2 days when observations continued after sunset, the last terns were seen 100 and 42 minutes before sunset (ESS, personal communication; ESS, Appendix A to BA). ESS (see Appendix A to BA) notes that travel between the Project Area and the roost at South Beach, or the colonies in Buzzards Bay, takes approximately 45 minutes. This suggests that the numbers of terns traveling in the Project Area after dark would be very low, if not zero. Therefore, this parameter was not modified for the 2008 alternative calculation.

There is some uncertainty surrounding the proportion of terns observed traveling verses foraging during the field surveys. ESS (see Appendix A to BA) notes that the birds recorded as traveling during the field surveys included those moving to a local feeding spot as well as those transiting the area; many of the terns recorded as foraging were likely to be foraging for much of their time spent over HSS, although they could be foraging at one moment then traveling the next moment. ESS (see Appendix A to BA) indicates that the field surveys provided 'snap shots' of tern activity in HSS so that the proportion of behaviors used in the 2007 draft model are appropriate. However, due to the concern of undetected high-flying terns (all of which would be hypothetically traveling), this parameter was changed to reflect a greater fraction of high flying terns for the 2008 draft.

The 2007 model considered those terns traveling at rotor height during crossings of the project area at risk of collision. The model considered 5 percent of terns traveling through HSS at risk of collision, based on the 4 to 6 percent of terns observed traveling during field surveys that were observed at rotor height. However, this parameter was revised for the 2008 alternative calculation due to the concern that high flying terns may have been undetected during field surveys (see Appendix A to BA).

The estimate for number of turbine rotors encountered during a single crossing of the project area (methods described previously in *Turbine Avoidance Behavior during Periods of Good Visibility)* is 0.04. This parameter, derived by applying the Bolker model, was not altered for the 2008 calculation. The estimated collision probability of roseate terns (as described previously in *Turbine Avoidance Behavior*) was based on the results of the Zeebrugge study. It was estimated that roseate tern collision probability would be comparable to sandwich tern collision probability at the Zeebrugge wind farm: 0.046–0.088 percent collision probability for flights at rotor height. The original model incorporated the range of collision probability observed for sandwich terns at Zeebrugge, while the 2008 alternative calculation considered only the higher of the two values for collision probability.

The results of the 2007 model indicate that the median mortality rate resulting from roseate tern collisions with the proposed turbines would be 0.83 individuals per year. Hatch and Brault (2007) ran an additional model to address uncertainty surrounding the 2007 model. A combination of Monte Carlo and data resampling methods were used to estimate the range of uncertainty surrounding the parameters of the model and to develop a probability distribution for the annual number of roseate tern collision mortalities. This distribution is based on 5,000 resamples. In 50 percent of the resamples, collision mortality did not exceed 0.83 individuals per year. Uncertainty in the parameter estimates lead to a wide range in uncertainty around this median value with 5 percent of resamples resulting in less than 0.01 collision mortalities per year and 5 percent of resamples resulting in greater than 8.2 collision mortalities per year. These extreme values are influenced by the lack of data regarding roseate tern occurrence in HSS and species specific avoidance behaviors. Sensitivity analysis demonstrates a narrow range of median annual kill rates (0.46 to 1.56), suggesting the robustness of the median value of 0.83 kills per year for uncertainties in estimates of roseate tern use of HSS and avoidance behavior. However, uncertainty in these parameters has a larger impact on the variance of the mortality estimates.

The result of the 2008 alternative collision calculation (which incorporates hypothetical high-flying terns, the higher value for the proportion of roseate terns among mixed flocks, and the higher of the two values for collision probability) indicate an estimate of 2.06 roseate tern collisions per year due to the proposed Project. This recalculation does not factor the sensitivity of the estimate of the different model parameters. However, as ESS (see Appendix A to BA) indicates, calculating mortality from the expected values yields a similar result.

There is some speculation that the WTG structures would be used as platforms for resting terns or as structures from which to initiate courtship flights. Neither draft of the collision model factored this increased risk because the original authors of the collision model assumed that the structures would have effective bird proofing devices under the adaptive management plan.

Population Viability Analysis

The following information provides detail on the methods and results from the Applicant's population viability assessment (PVA) of the roseate tern. In addition, Appendix C includes a response to comments from a December 2007 review of this PVA and several new runs of the

PVA based on these comments. MMS asks the FWS to consider this section as well as Appendix C as it evaluates the best available PVA for this species.

Arnold (2007) (Report No. 5.3.2-5) developed a population viability analysis (PVA) to demonstrate the range of mortality that the Northeast population of breeding roseate terns (excluding the Canada population) could tolerate without an increased risk of extinction. An alternative PVA was run by Arnold in 2008 (see Appendix C to BA) in order to incorporate updated life-history data not available when the 2007 PVA was developed. Although the new run of the PVA represents the most accurate analysis based on currently available data, the previous model was based on the best available scientific data at the time, as well as consultations with federal and state wildlife officials and the Roseate Tern Recovery Team. Therefore, the new model should be viewed as an alternative to the 2007 model based on current data (as of April 2008), and should be interpreted with the 2007 results.

The 2007 probability analysis (Report No. 5.3.2-5) assumed that all individuals from the Northeast population have an equal opportunity for encountering the proposed turbines. At the time of modeling, the most updated life history data was used to develop a model that incorporated three adult survival rate scenarios: 'best-case' (mean survival rates from 1988-1998, 'worst-case' (the lowest survival rates from 1988-1998), and 'recent trend' (mean survival rates from 1999-2005). The model considered annual variation in survival rates depending on environmental stochasticity as well as uncertainty in the life history data. Using the most updated survival and productivity parameters at the time of modeling, it was determined that there is a 95 percent chance that the population would fall below the threshold of 500 males (quasi-extinction) after 50 years in the absence of additional mortality resulting from the proposed action (the risk of quasi-extinction at 15 and 25 years without additional proposed action associated mortality is 9 percent and 42 percent, respectively) (Table 5a-c).

Table 5a.
Quasi-extinction Risk Evaluated at 15, 25, and 50 Years for Four Different Mortality Scenarios Assuming a Project Life of 20 Years and a Quasi-extinction Level of 500 Males

Collision Mortality (per year)	Evaluation Year		
	15	25	50
No take	9%	42%	95%
1	9%	43%	95%
2	9%	44%	95%
3	10%	44%	95%
4	10%	45%	95%
5	11%	46%	95%
10	12%	50%	96%
15	13%	53%	96%
20	16%	57%	97%
50	31%	76%	98%
100	64%	94%	99%

In evaluating the extinction risk for roseate terns in response to the proposed project, it is appropriate to assess the effect of collision mortality at 15 and 25 years because 50 years quasi-extinction risk is near 100 percent for all mortality scenarios, and any additional mortality would have minimal impact on extinction risk (see Report 5.3.2-5, Figure 4). Hatch and Brault (2007) (Report No. 5.3.2-1) determined that the median expected value for roseate tern collision mortality associated with the proposed turbines is 0.83 roseate terns (or about 0.4 male terns) per year. The alternative calculation provided by ESS (see Appendix A to BA) indicated a take of 2.06 roseate terns per year. According to the 2007 PVA, the take of 2 or less individuals would lead to a minimal increase in the risk of quasi-extinction (Table 5a). It is reasonable to assume that the loss of 0.4 or 1 males per year would have a similarly small, if not smaller effect. Hatch and Brault (2007) note that in the model roseate tern collision mortality exceeded 8.2 individuals per year in 5 percent of their resampling. Given that the sex ratio of the population is female biased (45 percent male), this is equivalent to 3.7, or more, males per year. The PVA indicates that a loss of 4 males per year will change the probability of quasi-extinction by 1 percent at 15 years, and 3 percent at 25 years. Extinction probabilities for the loss of 5 and 10 males per year are presented in Table 5a. The combined results of the collision mortality model and the PVA suggest that the potential for collision may result in adverse impacts to individual roseate terns.

Twelve new models were run by Arnold in 2008 (see Appendix C to BA). Changes to the 2007 PVA were made in two general areas: (1) changes in values of vital rates and scenarios developed from updated data, and (2) the use of a collision distribution model to estimate mortality. In the original PVA model, deterministic collision scenarios were used (a mortality level of 1, 2, 50, or 100, etc., individuals for each model run). In the new version, a distribution of collision mortality was used, with mortality varying for each run based on the shape of that distribution and the probabilities of different take levels occurring.

The revisions incorporated into the 2008 model (PVA Addendum) include no take scenarios (i) and collision distribution estimates based on (ii) 20 and (iii) 30 year project lives for:

1) PVA model run using collision risk estimates from Hatch & Brault (2007, Table 3), without any effects of the Bird Island Restoration Project.
2) PVA model run using collision risk estimates from Hatch & Brault (2007, Table 3), with maximum beneficial effect of the Bird Island Restoration Project (84 new breeding males in year 1).
3) PVA model run using collision risk alternative estimates (Collision Risk Addendum) without any effects of the Bird Island Restoration Project.
4) PVA model run using collision risk alternative estimates (Collision Risk Addendum) with maximum beneficial effect of the Bird Island Restoration Project (84 new breeding males in year 1).

All models were rerun with the following changes to vital rates and scenarios based on comments received regarding the 2007 model:

- Number of young produced (F_B) = 1.239 (variance = 0.119)

- Adult survival in the "best case" scenario = 0.8920, juvenile survival "best case" = 0.7109; new adult variance estimates (0.0083) and juvenile survival variance estimates (0.0155) were applied to adult and juvenile survival in all three scenarios
- A new ratio of the relative probabilities of occurrence of the "best case", "worst case" and "recent trends" (now called "1999-2005") of 69%:26%:5%.
- Juvenile survival was discounted by a total of 61 percent total during hurricane years
- The starting population was 3,443 males (not including any individuals added as a result of the Bird Island Restoration Project).

Table 5b.
Quasi-extinction Risk Evaluated at 15, 25, and 50 Years Assuming a Project Life of 20 Years and a Quasi-extinction Level of 500 Males a/

Mortality Estimate	Evaluation Year		
	15	25	50
No Take	0.0% (0.000)	0.2% (0.0025)	3.2% (0.0318)
H&B 2007 model, 20 year project life	0.0% (0.000)	0.3% (0.0029)	3.3% (0.0333)
H_alternative model, 20 year project life	0.0% (0.0001)	0.3% (0.0033)	3.6% (0.0359)

a/ Two mortality collision models were used: Hatch and Brault (2007, Table 3) and Hatch's alternative collision model (Collision Risk Addendum). No effects from the Bird Island Restoration Project were included.

Table 5c.
Quasi-extinction Risk Evaluated at 15, 25, and 50 Years Assuming a Project Life of 20 Years and a Quasi-extinction Level of 500 Males a/

Mortality Estimate	Evaluation Year		
	15	25	50
No Take	0.0% (0.0000)	0.2% (0.0022)	2.9% (0.0292)
H&B 2007 model, 20 year project life	0.0% (0.0000)	0.3% (0.0025)	3.2% (0.0318)
H alternative model, 20 year project life	0.0% (0.0000)	0.3% (0.0030)	3.4% (0.0342)

a/ Two mortality collision models were used: Hatch and Brault (2007, Table 3) and Hatch's alternative collision model (Collision Model Addendum). Maximum effects from the Bird Island Restoration Project were included (168 individuals in year 1).

With the alternative PVA (PVA Addendum), extinction probability is low throughout the model run, and never exceeds a 4% probability of extinction for the roseate tern population. Use of Hatch's alternative collision risk model increased probability of quasi-extinction over the 2007 model only at the 50-year mark in all cases, with maximum increases occurring for 30-year projects. For 20-year projects, use of the alternative collision risk model increased quasi-extinction probability by 0.3% at the 50-year mark (Table 5b).

The Bird Island Restoration Project served to decrease the probability of quasi-extinction. Decreases were observed only at the 50-year mark, and maximum decreases were observed for 30-year projects. For 20-year projects, the effect of successfully adding breeding pairs into the model decreased quasi-extinction probability by 0.1% to 0.2% under the results obtained when no breeding pairs were added (Table 5c).

Overall, the 2008 model (PVA Addendum) deviates significantly from the 2007 model, in that the original calculated nearly a 100% risk of quasi-extinction by the 50-year mark even with no mortality from collision. With the alternative run, there is a quasi-extinction risk of 3.2% at the 50-year mark with no take, and this number drops to 2.9% when additional breeding pairs from the Bird Island Restoration Project are added to the model.

Summary

Roseate tern crossings of the proposed action area may occur during low visibility periods which could lead to the potential for increased risk of collision during breeding and staging periods, and during migration. Data on tern occurrence, flight behavior, and movement patterns in HSS during periods of low visibility and at night is not available. There are available studies that indicate that terns often arrive at wintering ground roosting areas after dark, and depart before sunrise (Hays *et al.,* 2003; Hays *et al.,* 1999; Nisbet, 1984). Trull et al. (1999) found that roseate and common terns continued to arrive at staging areas in Massachusetts after dark. Terns are believed to be mainly active during the day during the breeding and post-breeding staging seasons as they visually detect their prey; however, there is evidence of tern crepuscular flights over Nantucket Sound as terns commute to and from roosting sites, and it is possible that nocturnal activity in Nantucket Sound occurs during these periods and during migration. Terns will fly at night if disturbed by predators but this activity would occur in proximity to colonies and roosts.

The risk of collision during periods of restricted visibility is high. Studies conducted at offshore wind farms in Europe suggest that flight activity of waterbirds offshore during inclement weather (at night) during migration is reduced (Peterson *et al.,* 2006). Decreased occurrence in the project area at night during inclement weather would result in decreased probability of collision. There are some project features which may reduce the risk of collision if terns were to occur in the project area at night. Terns may avoid WTGs due to natural light sources (i.e., starlight or moonlight). The FAA lighting mounted on the nacelle of the turbines may also allow terns to visually detect the towers (not necessarily the blades) and may facilitate avoidance of the WTG area as terns are not believed to be among avian species that are attracted or disoriented by artificial lighting on tall structures. However, because data is not available regarding tern activity in HSS during these light restricted periods, it is appropriate to be conservative and presume that impacts due to collision mortality of even a single individual roseate tern represents a moderate adverse impact.

5.3.1.2.4 Increased Predation

There is a potential that WTG and ESP foundation structures may provide perching habitat for predatory peregrine falcons (*Falco peregrinus*), which could result in the mortality of roseate terns. Peregrine falcons aerial hunt or hunt from perches while they take avian prey. They are known to rarely take tern species (Wheeler, 2003). Peregrine falcon have been known to infrequently, but regularly take or attempt to take terns at the colonies in Buzzards Bay, particularly during the spring (MDFW, personal communication) ; there was a tern found predated at Bird Island after a peregrine was observed there on June 11, 2006 (Causey and Mostello, 2006); and were peregrine falcons were frequently reported hunting terns nesting at Petit Manan and Green Island in Maine, during the 2007 breeding season (USFWS, 2007); these islands are located 2.5 miles from the mainland.

There is a population of arctic nesting peregrine falcons that migrate south between mid-September and late-October. Banding and telemetry data indicate that peregrine "migration routes are distinctly centered along the Atlantic Coast" during fall migration (Wheeler, 2003). Peregrine falcons will also make major over-water crossings from Baffin Island or Labrador to the mid-Atlantic Coast (Wheeler, 2003).

There is some seasonal overlap between roseate terns and migrating arctic-nesting peregrine falcons within the Atlantic Coast region; particularly in the spring when predation is observed at the Buzzards Bay colonies (MDFW, personal communication). Arctic nesting peregrine falcon fall migration peaks in late-September to early-October (Wheeler, 2003) and roseate terns migrate south by mid-September. Limited information is available regarding peregrine falcon spring migration. However, telemetry data indicates that peregrine falcons reach breeding grounds by May (Wheeler, 2003), at which time roseate terns return to Nantucket Sound. Mainly the winter range of the arctic nesting peregrine falcons overlaps with the proposed action area (Wheeler, 2003) when roseate terns are not present. There is also a small population of peregrine falcons that are generally year-round residents in Massachusetts (Massachusetts had 14 known territorial pairs in 2007 [MNH & ESP, 2007]). Breeding territories occur along the Connecticut River Valley, the Lowell-Lawrence area, the Worcester area, and Boston (MNH & ESP, 2007). Most of the breeders and first-year birds are non-migratory, but they disperse toward the coast in the winter and the spring. Some first-year birds will disperse to other Northeastern states where they will eventually breed. During the spring and summer, if a member of a breeding pair in Massachusetts is killed, that individual is generally quickly replaced, indicating the presence of a number of non-breeding birds in the area (USFWS, personal communication).

Peregrine falcon are known to regularly take advantage of artificial structures for perching opportunities (Wheeler, 2003); peregrines will perch, and sometimes nest on, lighthouses, telecommunication towers, grain elevators, suspension bridges, and other tall, man-made structures (USFWS, personal communication); however, the extent to which artificial structures are used for perching at offshore locations is unknown.

It is possible that the WTG and ESP platforms will provide perching substrate for both roseate terns and predatory peregrine falcon (USFWS, personal communication). Given that the anti-perching devices on the WTG and ESP are effective (Section 8 describes the adaptive management strategy for perch deterrent devices), and because of the use of tubular towers instead of lattice towers which do not provide as much perching opportunity, it is anticipated that development of the proposed action will not result substantially increase hunting opportunities for predatory species or result in substantial increases of predation of roseate terns. Therefore, the potential of increased predation is anticipated to result in discountable adverse impacts to roseate terns.

5.3.1.2.5 Vessel traffic

Increases in vessel traffic could result in impacts to roseate terns during the construction, operation, and decommissioning phases of the proposed action. A large vessel(s) would be used to transport and install the monopiles, towers, nacelles, hubs, and blades during construction and decommissioning. The vessel would be loaded in Quonset, Rhode Island, and would be anchored near the monopiles that are undergoing construction. During installation and decommissioning of the WTGs, the large vessel would make several trips from Quonset to the proposed action area. Additionally, small vessels from Falmouth, Massachusetts, and a maintenance support vessel from New Bedford would make regular trips to HSS during the construction period. While the proposed turbines are in operation, there would be regular vessel trips made from Falmouth and New Bedford harbors to the proposed action area. The expected maintenance schedule would be approximately 2 vessel trips per day for 252 days per year (5 maintenance days per turbine per year) (see Section 2 of the DEIS for a proposed action description). Disturbances to breeding terns would be avoided at colony locations as maintenance vessels would not be loaded, and would not travel, in the direct vicinity of tern colonies.

During high surf conditions, workers may be transported by helicopter to the platform on the ESP. There may also be occasional helicopter landings at the ESP in association with some regular maintenance activities. An increase in recreational fishing may occur around the WTGs if fish populations aggregate around foundations. The arrival of vessels and helicopters could temporarily displace terns from localized areas within the larger proposed action area. This type of disturbance already occurs to some extent within and adjacent to the proposed action area due to existing levels of vessel activity. Disturbances to breeding terns would be avoided at colony locations as maintenance aircraft would not travel over or in the direct vicinity of tern colonies.

Terns appear to be less sensitive to human disturbances than other species of birds, and are also thought to be attracted to some areas of human activity (Borberg *et al.,* 2005,; Drewitt and Langston, 2006; Sadoti *et al.,* 2005a). Terns are known to habituate to some levels of human presence and disturbance. Terns are regularly observed traveling and foraging in the vicinity of vessels and other man-made structures. Two of the major Northeast roseate tern breeding colonies on Bird and Ram Islands in Buzzards Bay are located 2.8 mi [4.5 km] and 5.6 mi [9.01 km], respectively from the entrance of the Cape Cod Canal which receives frequent recreational boating and commercial shipping activity; yet terns continue to colonize these islands. Biologists frequently visit the large roseate tern colonies on the Atlantic Coast and consequently, roseate terns have become habituated to their presence and their handling of eggs, chicks, and adults (Nisbet and Spendelow., 1999). An increase in the presence of terns and gulls observed in areas around the Horns Rev offshore facility in Denmark was presumed to be associated with increased boat activity for maintenance activities (Petersen *et al.,* 2006). Therefore, roseate terns are expected to continue their traveling and foraging activities despite the presence of increased boat traffic and the few anticipated helicopter landings in HSS. The approach of aircraft or boats may cause terns to flee the area (see Risk of Collision for discussion about increased risk of collision due to fleeing behavior). These disturbances would be temporary and terns would be expected to return to the area after the departure of the vessels.

Roseate terns are expected to be among those species of bird that would habituate to the presence of increased boat traffic associated with maintenance activities. Therefore disturbances associated with vessel traffic during facility operation are anticipated to have minimal effects on roseate terns.

5.3.1.3 Proposed Action Analysis-Routine Conditions

Piping Plover

Potential avian impacts associated with construction and operation of the proposed action could include loss of habitat, disturbances associated with the presence or activity of construction equipment or maintenance vessels, disturbances such as barriers to flight paths due to the presence of the turbines, and risk of collision.

Minor to moderate adverse impacts to piping plover are anticipated during the routine activities associated with construction, operation, and decommissioning of the proposed action. The proposed action area does not occur within breeding or staging habitat, or within a known migration or movement corridor.

The effects of loss of habitat or habitat modification would be discountable or insignificant. Using HDD technology, the shoreline would be drilled under for cable placement, there would be no disturbance of beach areas. There would be an 820 ft (250 m) (or greater buffer) between the closest breeding beach and the proposed submarine transmission cable. Any construction activities would take place offshore, therefore, disturbances associated with offshore construction activities including increased vessel traffic and the presence and operation of construction equipment are not anticipated. A wire may placed across the beach located closest to the submarine cable in order to power the drill head, however, disturbance to nesting piping plover would be equal to a person walking on the beach and will be avoided by maintaining a 300 m buffer around any nesting location during this temporary action. The proposed landfall is greater than 1.5 miles (2.4 km) to the nearest breeding locations; therefore, disturbances associated with construction and operation of the facility are not anticipated.

There are no known features that would funnel piping plover across the proposed action area if their movements were to result in crossings of Nantucket Sound during the breeding season or migration season. Therefore, the presence and operation of the WTGs is not expected to present a major barrier to the flight paths of transient plovers. Piping plovers that encounter turbines during crossings of the Sound may avoid collisions with WTG structures depending on visibility however piping plover turbine interaction behaviors require further investigation. If piping plover were to make altercations to their flight paths if they were to encounter a WTG, it is expected that minor changes to piping plover flight behavior would result in minimal increases in energy expenditure. Therefore, the presence of WTGs in HSS may affect piping plover by causing avoidance flights around the project footprint, but these effects are expected to be minor.

Piping plover cross areas of Nantucket Sound to access breeding locations during migration or dispersal, and may sporadically cross the Sound during the breeding period. However, the flight paths of piping plover through the Sound are not known. The migration flight paths of piping plover along the Atlantic Coast are expected to occur within a narrow corridor along the outer beaches of the coast, but some birds may rarely occur offshore or inland. Piping plover migrate both day and night and could travel during periods of inclement weather when visibility is reduced. However, studies suggest that migration of birds is reduced during periods of inclement weather (Petersen *et al.,* 2006). Waterbirds have demonstrated turbine avoidance behaviors both during the day and at night. If piping plover were to occur within the proposed action area, they may visually detect and avoid the WTG area due to FAA lighting on the nacelles as well as sources of natural lighting. Piping plover are not among avian species that have demonstrated disorientation due to lighting on tall structures when traveling during fog or rain, avian species known to be impacted are mainly passerines.

More information is required to assess piping plover use of the proposed action area during migration and the breeding season, during the day and at night, and during a range of weather conditions. The actual number of crossings of the proposed action area per year, the average height of flight during crossings, and the turbine avoidance rates specific to piping plover are not known. Although piping plover are expected to infrequently and sporadically occur in HSS, available information provides some insight into the potential range of effects but great uncertainty still remains. It is important to be conservative in such a situation and consider any impact associated with collision risk a moderate adverse impact to piping plover.

Roseate Tern

The routine activities associated with the proposed action's construction, operation, and decommissioning that could potentially result in impacts to roseate terns include loss of habitat or prey displacement during construction, barriers to flight paths due to the presence of WTGs, collisions with the proposed action's structures, increased predation, and/or disturbances associated with increased vessel traffic.

The available baseline surveys in Nantucket Sound indicate relatively low use of HSS by terns for traveling and foraging (refer to *Results of Surveys and Available Information*). Because of the small footprint of the actual development area, minimal habitat loss is anticipated during the proposed action's construction, operation, and decommissioning activities. Impacts associated with displacement of prey fish during construction are anticipated to be minimal and temporary. The natural benthic substrate and prey fish communities would be maintained to the greatest extent possible. However, the additional substrate (as described in Section 5.3.1.2.1, *Habitat loss or Modification*) would be oriented vertically in the water column, and could result in a localized and minor increase in certain fish prey species. The increase in prey fish ultimately may attract tern species to the area to forage to some extent (see Section 5.1.1.2.3, Risk of Collision for discussion of increased risk of collision). Terns have demonstrated relatively low use of the proposed action area in relation to other areas surveyed in the project area including the waters offshore of southern Cap Cod and the waters surrounding Monomoy Island and Muskeget Island (refer to *Results of Surveys and Available Information*). Therefore, adverse effects associated with loss of habitat or habitat modification are not anticipated.

As terns are known to travel and forage in the vicinity of other man-made structures, including wind turbines, it is likely that roseate terns would continue to use the proposed action area after construction. Although the majority of terns are expected to avoid the direct WTG rotor swept area, it is anticipated that terns would continue to travel and forage in the vicinity of the proposed action. Tern surveys in HSS documented minimal use of the proposed action area, therefore, the proposed action is not anticipated to present a major barrier to the flight paths of terns. The proposed action is not expected to substantially increase energy expenditure as terns travel around the direct area of WTGs. Also, because turbines are widely spaced (0.34 to 0.56 NM [0.63 to 1.0 km] apart), it is anticipated that some terns would occur between turbines while traveling or foraging as they have been observed to do at existing offshore facilities with smaller spacing between turbines. Therefore, the presence of the turbines may affect roseate tern behavior to some extent, but is not anticipated to adversely affect roseate terns.

As was observed at the Zeebrugge facility, an increased number of flights past turbines may result in an increased risk of collision due to more exposure to towers and spinning blades. If tern use of HSS increases due to changes in breeding or roosting locations, or due to increases in prey fish abundance around the WTG underwater structures, the risk of collision may increase. Courtship flights in the vicinity of WTGs could increase the risk of collision as well. The adaptive management plan for perch deterrents (as described in Section 8) has been developed to discourage such activities as high courtship flights from occurring near the WTGs. Actively foraging terns would be expected to remain below the rotor-zone and would be at decreased risk of collision with spinning blades. Because roseate tern turbine avoidance rates during periods of good visibility are expected to be high, impacts associated with collision during periods of daytime fair weather are anticipated to be discountable. Roseate terns may fly higher in following winds and may occur within the rotor zone while commuting; however, terns may be at decreased risk of collision with rotors if flying with following winds through the rotors because of the shorter length of time spent in the rotor-zone due to a higher ground speed (Report No. 5.3.2-1); and because during the day, terns are expected to visually detect turbines. Although flights into headwinds at rotor height would be more dangerous due to a greater amount of time spent in the rotor-zone while passing, terns are expected to fly closer to the water's surface in headwinds for to avoid excessive energy expenditure, and would therefore not be expected to fly in the rotor-zone during such conditions. Collision fatalities associated with periods of high winds and good visibility is expected to be unusual occurrences, however, any level of mortality to endangered roseate terns is considered a moderate adverse impact. The risk of collision during periods of restricted visibility is high. Studies conducted at offshore wind farms in Europe suggest that flight activity of waterbirds offshore during inclement weather (at night) during migration is reduced (Peterson *et al.,* 2006). Decreased occurrence in the project area at night during inclement weather would result in decreased probability of collision. There are some project features which may reduce the risk of collision if terns were to occur in the project area at night. Terns may avoid WTGs due to natural light sources (i.e., starlight or moonlight). The FAA lighting mounted on the nacelle of the turbines may also allow terns to visually detect the towers (not necessarily the blades) and may facilitate avoidance of the WTG area as terns are not believed to be among avian species that are attracted or disoriented by artificial lighting on tall structures. However, because data is not available regarding tern activity in HSS during these light restricted periods, it is appropriate to be conservative and presume that adverse impacts associated with risk of collision during these periods may be moderate for roseate terns.

The collision probability model suggests that the development of the proposed action could result in adverse impacts to individual roseate terns (the 2007 and 2008 drafts estimate that 0.83 and 2.06 roseate terns, respectively, may be killed per year during the life of the project). There is uncertainty surrounding the collision risk probability model because the actual number of roseate terns crossing the proposed rotor-swept area each year and the roseate tern turbine-avoidance rates are estimates only. According to the two PVA alternatives, the take of 2 or less individuals would lead to a minimal increase in the risk of quasi-extinction. There is some uncertainty surrounding the PVA due to the unpredictability of stochastic events. However, these models are based on the most current life history data (as of April 2008) and were developed in consultation with roseate tern and piping plover experts. The models are therefore the best available projections of potential proposed action impacts.

Peregrine falcons aerial and perch hunt, and are known to take species of tern. There is some overlap of predatory peregrine falcon during migration with the arctic species, particularly in the spring, and with resident species. It is possible that the WTG and ESP platforms will provide perching substrate for both roseate terns and predatory peregrine falcon. Given that the anti-perching devices are effective (Section 8 describes the adaptive management strategy for perch deterrent devices), and because of the use of tubular towers instead of lattice towers which do not provide as much perching opportunity, it is anticipated that development of the proposed action will not substantially increase hunting opportunities for predatory species or result in substantial increases of predation of roseate terns. Therefore, the risk of increased predation is anticipated to result in discountable impacts to roseate tern.

Roseate terns are expected to be among those species of bird that would habituate to the presence of increased boat traffic and other disturbances associated with construction and maintenance activities. Roseate terns tolerate a range of human disturbances at breeding locations where they would be considered most vulnerable to impacts. Terns do not breed in the vicinity of the proposed action and have demonstrated relatively low use of the area for traveling, and less use of the area for foraging. There is risk of collision of roseate terns with the proposed WTGs. If use of the area increases due to changes in prey availability in the project footprint, there would be more crossings of the project area, increasing the risk of collision. Although risk of collision is expected to be low during daytime periods of fair weather, there is an unknown level of risk of collision during periods of decreased risk of collision. Because use of HSS by terns during low visibility conditions is unknown, it is necessary to be conservative and consider any level of mortality to be an adverse impact. Therefore, impacts resulting from the routine activities associated with construction and operation of the proposed action may result in moderate adverse impacts to roseate terns.

5.3.1.4 Summary and Conclusion-Routine Conditions

Piping Plover

The preliminary assessment determines that routine activities associated with the proposed action's construction, operation, and decommissioning would result in minor to moderate impacts to piping plover. There would be no loss of critical habitat and no loss of nesting or staging habitat. Due to the 250 m (or greater) buffer of the submarine cable from the nearest nesting beaches, disturbances associated with offshore construction or operation activities are not anticipated for nesting piping plover. In addition, since the shoreline would be drilled under for cable placement, there would be no disturbance of beach areas. Maintaining a 300 m buffer around any nesting areas during placement of a wire to power the drill head on the beach that is closest to the submarine cable would result in a discountable level of disturbance to piping plover. Offshore vessels and construction activities may result in minimal disturbances to piping plover; however, these impacts are anticipated to be temporary and minor. The proposed landfall site is 1.5 miles (2.4 km) from the nearest nesting beach and, therefore, onshore construction activities are not expected to impact nesting piping plover.

Relatively few piping plover crossings of Nantucket Sound are expected and there are no topographical features that would funnel transients through HSS. Therefore, the presence of the WTGs may affect the flight behaviors of piping plover;, however, minor adverse impacts are anticipated.

There is a greater risk of collision of piping plover with WTG structures during nighttime migration movements or crossings of HSS during periods of reduced visibility. However, crossings of HSS are expected to be few in relation to the potential number of piping plover crossings of Nantucket Sound that may occur over the course of a year. Piping plover may visually detect and avoid the WTG area based on FAA lighting and natural sources of lighting. Piping plover are not anticipated to regularly occur within the proposed action area during periods of inclement weather; however, surveys have not been conducted during these conditions so piping plover occurrence in HSS during these periods can not be ruled out. The loss of an individual piping plover due to collision mortality is considered a moderate adverse impact.

Impacts associated with routine activities of the proposed action are anticipated to have discountable to moderate adverse impacts to piping plover. Therefore, mitigation, monitoring and reporting measures have been incorporated into the proposed action (refer to Section 8.0) to reduce or eliminate the potential for impacts to the piping plover population.

Roseate Tern

Roseate terns are sensitive to additional sources of mortality due to their generally declining population and certain characteristics of their reproductive biology. The preliminary assessment determines that routine activities associated with the proposed action's construction, operation, and decommissioning would result in discountable to moderate adverse impacts.

Roseate terns are known to habituate to the presence of man-made structures and to tolerate a range of human disturbances. Disturbances associated with construction and operation of the proposed action are expected to be discountable and temporary. Displacement of prey fish may occur during construction activities. Temporary but local displacement of roseate terns resulting from an increase in vessel traffic may occur during construction and operation. Over time, the abundance of certain prey fish species may increase in the footprint of the project due to the addition of substrate oriented vertically under water, which may result in increased use of the area by foraging roseate terns.

The presence of WTGs and the spinning blades may cause terns to avoid the rotor zone of the WTGs, depending on lighting and weather conditions, although proposed turbine spacing would allow for continued use of the area outside of the proposed action's boundaries and in between turbines.

Available information suggests that roseate terns have demonstrated relatively low use of the proposed action's area and the majority of flight heights observed in the proposed action area were below the proposed rotor-zone. Some terns are expected to travel through HSS at the height of the rotors, particularly those flying downwind. It is possible that roseate terns will occur in HSS during crepuscular periods and periods of inclement weather because studies in HSS during these conditions have not been conducted. Roseate terns are known to be active after sunset and at night and could occur in HSS during these periods.

Roseate terns would be expected to visually detect and avoid turbine structures during periods of good visibility, and may avoid turbines if they were to occur in the proposed action area at night, depending on visibility. The risk of collision for roseate terns would increase proportionately if terns began to occur in HSS more frequently to forage, or to travel (i.e., if there are shifts in the number of terns present at nearby roosts or colonies). Also, if the adaptive management strategy for perch deterrents is faulty, it is possible that courtship flights may occur near the WTGs, increasing the risk of collision. The loss of a single roseate tern individual would be considered a moderate adverse impact.

There is some overlap of roseate terns and peregrine falcons in the proposed action area and peregrines are known to hunt terns at colonies in Buzzards Bay, particularly in the spring. Peregrine falcon are known to hunt at islands and perch on coastal artificial structures; however, it is unknown to what extent peregrine falcon take advantage of offshore perches to hunt prey. The adaptive management perch-deterrent plan, if effective, would discourage predatory peregrine falcon from increased predation of roseate terns in HSS.

Impacts associated with routine activities of the proposed action are anticipated to have minor to moderate adverse impacts to roseate terns. Therefore, mitigation measures have been proposed (refer to Section 8.0) to reduce or eliminate the potential for impacts to the roseate tern population.

5.3.2 Non-routine, Accidental or Unplanned Events

Potential sources of impacts to piping plover during non-routine, accidental, or unplanned events associated with the proposed action's construction, operation, and decommissioning include oil spills and cable repair.

Potential sources of adverse impacts to roseate terns during non-routine, accidental, or unplanned events associated with the proposed action's construction, operation, and decommissioning include oil spills, monopile collapse, cable repair, and geotechnical and geophysical investigations.

5.3.2.1 Oil Spills

Piping Plover

Although oil tanker trips near the proposed action are infrequent, the presence of WTG and ESP foundations in the vicinity of oil tanker shipping lanes increases the risk of ship collisions, and possibly oil spills. The contents of tankers may be released, or fluids contained within the ESP or WTG structures could be released. The likelihood of an oil spill as it relates to the proposed action is drastically reduced due to the minimal shipping traffic that takes place in the vicinity of HSS. As noted in Section 4.4.3 of the DEIS, Nantucket Sound is not a main thoroughfare for commercial shipping, as through Buzzards Bay and the Cape Cod Canal. In addition, the DEIS notes, "The location of the site of the proposed action relative to established vessel routes, physical water depth restrictions on HSS and the large WTG grid spacing combine to limit the potential for a vessel to collide with a WTG."

Depending on the size and location of an area impacted by an oil spill, spills could result in the direct mortality or decreased breeding success of piping plovers. If the feathers become coated with oil, birds loose their ability to repel water and to insulate (Jarvis, 2005). Potential impacts include mortality from heat loss, starvation, or drowning. Some birds may loose their ability to fly. Mortality can result if toxins are ingested through water or during preening. Also, nesting birds can transfer oil to their eggs resulting in decreases in hatching success, developmental problems, or the mortality of embryos (Jarvis, 2005).

Oil spills can impact large areas if the spills are not immediately contained. The coastline of Buzzards Bay was impacted when the *Bouchard No. 120* collided with rocks off the coast of Westport Massachusetts in 2003. Oil was reported as far as Block Island and Middletown, Rhode Island (BBNEP, 2003). Piping plover were impacted by the oil spill, particularly at Barney's Joy, Dartmouth Massachusetts. Two piping plover were reported dead as a result of oil slicking. However, overall nesting success that year was not presumed to be adversely impacted (BBNEP, 2003). Oil spills that occur when piping plovers are not present could result in indirect effects. Donlan *et al*. (2003) identified habitat loss as an indirect effect as a result of the 1996 North Cape oil spill which impacted a plover nesting site during the non-breeding season. The spill resulted in a prey-resource loss, subsequently increasing foraging costs and impacting nesting success.

The potential impacts of oil spills associated with the proposed action would be situational depending on the location and size of the area affected by a spill. Large spills or spills that are not quickly contained could result in the loss of piping plover adults or could lead to decreased nesting success. Oil spills that occur outside of the breeding or dispersal periods could result in no impact to piping plover. Due to the distance between the WTG area and the closest piping plover nesting location (approximately 5 mile [8 km]), the potential for impacts are reduced. Additionally, a Spill Prevention Control and Countermeasure (SPCC) Plan would be implemented during construction, operation, and decommissioning. In the event of a spill, clean-up measures would be used to prevent contamination of the environment and impacts to wildlife.

Roseate Tern

Because terns forage at the water's surface, they are among those species of birds that are particularly vulnerable to oil spills (Jarvis, 2005). If the feathers become coated with oil, birds loose their ability to repel water and to insulate, and in some instances, loose the ability to fly. Potential impacts include mortality from heat loss, starvation, or drowning. Mortality can result if toxins are ingested through water or during preening. Also, nesting birds can transfer oil to their eggs resulting in decreases in hatching success, developmental problems, or the mortality of embryos (Jarvis, 2005).

Oil spills can impact large areas if the spills are not immediately contained. The coastline of Buzzards Bay was impacted when the *Bouchard No. 120* collided with rocks off the coast of Westport Massachusetts in 2003. Oil was reported as far as Block Island and Middletown, Rhode Island (BBNEP, 2003). At least three adult roseate terns were found dead with traces of oil. Roseate terns were discouraged from nesting on Ram Island in 2003 because it was soiled from the oil spill. Consequently, 250 pairs nested on Penikese Island that year and productivity suffered due to the late initiation of egg-laying (BBNEP, 2005). Oil spills that occur when terns are not present could result in indirect effects to habitat availability and prey availability.

The potential impacts of oil spills associated with the proposed action would be situational depending on the location and size of the area affected by a spill. Large spills or spills that are not quickly contained could result in the loss of roseate tern adults or could lead to decreased nesting success. Oil spills could directly impact roseate tern colonies, as the Ram Island colony was impacted in 2003. However, due to the distance of the proposed action from nesting colonies, oil spills associated with the proposed action are unlikely to impact nesting colonies. Additionally, a SPCC Plan would be implemented during construction, operation, and decommissioning. In the event of a spill, clean-up measures would be used to prevent contamination of the environment and impacts to wildlife.

5.3.2.2 Cable Repair

Piping Plover

The disturbances associated with cable repair activities are expected to be similar to or less than construction activities. Maintenance activities would be restricted to a small area and would be temporary. Due to the 820 ft (250 m) (or greater) buffer of the submarine cable from the nearest nesting beaches, disturbances including increased human presence and vessel traffic associated with offshore maintenance activities are not anticipated to impact nesting piping plover. These activities would not impact beach areas as the cables would be under the shoreline.

Roseate Tern

Cable repair activities would be similar to cable installation activities, but would occur for a short period in a small discrete location. Cable jetting, splicing, and re-jetting would result in minor and temporary increases in suspended sediments and would temporarily disturb benthos. Tern foraging in areas of elevated suspended sediments would be reduced. In both instances the habitat and species would recover and no impacts to roseate terns are anticipated from cable repair activities.

5.3.2.3 Monopile Collapse

Piping Plover

Piping plover are largely present along the coast, particularly during the breeding season, and monopile collapse is expected to have a discountable or insignificant affect on this species.

Roseate Tern

In the event of a monopile collapse, recovery and replacement activities would be similar to decommissioning and construction of a single WTG. A very minor amount of benthic habitat would be disturbed with a short term and localized increase in suspended sediments. Foraging opportunities for terns would be reduced in areas of elevated suspended sediments. Some lubricating fluid would likely leak from the submerged nacelle, but would rapidly disperse given the small quantity involved. However, should a tern dive for fish within this small plume, it could be harmed. There is a low likelihood of this occurrence and low probability of it occurring coincidentally with tern use of the immediate area. Potential impacts to roseate tern in the event of a monopile collapse would therefore be discountable or insignificant.

5.3.2.4 Geotechnical and Geophysical Investigations

Piping Plover

Prior to receiving authorization to construct the proposed action, the Applicant would be performing additional geotechnical and high resolution geophysical investigations to assist in final analysis of certain design elements of the proposed action, such as depth of monopile foundations. Geotechnical investigation methods such as borings would result in discountable or insignificant effects on benthos and water column characteristics, and these activities would be localized and short term, such that no affects on piping plover habitat or use of the proposed action area are anticipated. In addition, these activities will be focused on the HSS portion of the proposed action area, and this is distant from most of the frequently used habitats in Nantucket Sound. Geophysical investigation methods, such as sidescan sonar, are even less intrusive and have less habitat altering capabilities, and would, therefore, also have no adverse effects on piping plover

Roseate Tern

The geotechnical investigation methods such as borings would result in discountable or insignificant effects on benthos and water column characteristics, and these activities would be localized and short term, such that no affects on roseate tern habitat or use of the proposed action area are anticipated, even though much of this activity will be focused on the HSS area. Geophysical investigation methods, such as sidescan sonar, are even less intrusive and have less habitat altering capabilities, and would, therefore, also have no adverse effects on roseate terns.

5.3.2.5 Proposed Action Analysis - Non-routine, Accidental, or Unplanned Events

Piping Plover

The impacts associated with accidental events such as oil spills would be situational depending on the location and size of the spill, how quickly the spill is contained, and the season during which a spill were to take place. However, given the distance of the proposed action area from piping plover nest locations, potential impacts are reduced. A spill during the breeding season could result in decreases in piping plover reproductive success or increased mortality of adults. Indirect impacts from oils spills may result for piping plover, including loss of prey-resources at foraging habitats, even when not present in the area.

Maintenance activities associated with cable repair would result in minor and temporary disturbances to nesting piping plover due to the 820 ft (250 m) or greater buffer between the submarine cable and nesting locations. Therefore, disturbances associated with cable repair including increased human presence and vessel traffic are expected to have discountable or insignificant to minor impacts to nesting piping plover.

Roseate Tern

Roseate terns could be affected by non-routine, accidental, or unplanned events associated with the construction, operation, and decommissioning of the proposed action. These events include oil spills, monopile collapse, cable repair, and geotechnical and geophysical investigations.

Depending upon the size and season of an oil spill it could result in a minor impact to roseate terns. Indirect impacts from oils spills may result for roseate terns even when not present in the area. A spill in Nantucket Sound could result in the decreased breeding success or mortality of roseate terns. However, an oil spill is an unlikely event. Furthermore, if a spill were quickly detected and contained, negative impacts could be minimized or avoided.

Other activities such as cable repair or monopile collapse are expected to have discountable or insignificant to minor impacts to the population of the roseate terns because these impacts would be localized and temporary.

The likelihood of the described non-routine, accidental, or unplanned events, associated with the three phases of the proposed action, to result in adverse impacts to roseate terns is low. Therefore, it is anticipated that such unplanned events would result in discountable impacts to roseate terns.

5.3.2.6 Summary and Conclusion - Non-routine, Accidental, or Unplanned Events

Piping Plover

Potential impacts associated with non-routine, accidental, and unplanned events during construction, operation, and decommissioning of the proposed action could result in discountable or insignificant to minor impacts to piping plover.

The chance of an event of an oil spill is unlikely, however, potential impacts associated with a spill would depend on the size and location of the spill, the season in which it were to occur, and how quickly it would be contained. The range of impacts associated with an oil spill includes no impacts, indirect impacts to habitat, decreased breeding success, or the mortality of piping plover. Due to the distance of the proposed action from nesting locations, potential impacts are reduced. Therefore, oil spills may result in minor adverse impacts to piping plover. Activities associated with cable repair are expected to be temporary and minor.

Roseate Tern

Potentially minor impacts to roseate terns could result from non-routine, accidental, or unplanned events associated with development of the proposed action. Sources of potential impacts include oil spills, monopile collapse, cable repair, and geotechnical and geophysical investigations.

The impacts associated with accidental events such as oil spills would be situational depending on the location and size of the spill, how quickly the spill is contained, and the season during which a spill were to take place. However, given the distance of the proposed action area from roseate tern colonies, potential impacts are low. A spill during the breeding season could result in decreases in roseate tern reproductive success or increased mortality of adults. If a spill were to occur when roseate terns are not present within the region, indirect impacts to habitat and prey availability could occur. However, there is low probability of an oil spill event due to the location of the WTGs.

Cable repair, monopile collapse and geotechnical and geophysical investigations would result in minor and temporary disturbances to roseate tern behavior and use of the proposed action area, therefore, these activities are expected to have discountable or insignificant to minor impacts to roseate terns.

6.0 CUMULATIVE EFFECTS

Other marine-based activities in the past, present or future that may contribute to cumulative impacts in Nantucket Sound would include activities such as submarine electric cable or gas pipeline installations, harbor and channel dredging and disposal activities, commercial fishing (bottom dragging), commercial shipping, sand and gravel mining, installation of pile-supported or solid fill marine structures, residential and commercial coastal development, coastal recreational activities, beach management activities including beach nourishment, communication tower and navigational structure installations, and other offshore wind power or other sources of alternative energy installations. Of these activities, those that have the potential to occur within the location and/or timeframe of the proposed action and that may contribute to overall impacts to listed whale, sea turtle, and avian species include: offshore sand and gravel mining, offshore wind energy projects and other sources of alternative energy installations, maintenance dredging/beach nourishment, coastal development, coastal recreational activities, and the installation of communication towers and navigational structures. Although other activities listed above could occur in the general proposed action vicinity, a detailed cumulative impact analysis determined that these activities would have little potential for any cumulative impacts to environmental resources, including listed whale, sea turtle, and avian species.

Geographically, the cumulative impact study area includes an area extending from the area of the proposed action eastward of Monomoy Island, Massachusetts, southward to Horseshoe Shoal and the south shore of Martha’s Vineyard, westward through Vineyard Sound and Buzzards Bay and north through Narragansett Bay to Quonset, Rhode Island. This geographic study area includes a broad scope of onshore and offshore projects that have been constructed, or may have the potential to be constructed in the future that could affect the location of the proposed action (Figure BA-14).

An assessment of the possible cumulative effect of impacts caused by offshore sand and gravel mining, offshore wind energy projects, maintenance dredging/beach nourishment, coastal development, coastal recreational activities, and the installation of communication towers and navigational structures activities when combined with proposed action impacts is provided below.

6.1 Offshore Sand and Gravel Mining

The mining of sand resources for beach nourishment may lead to impacts or increase stress on commercial and noncommercial living resources that utilize the subject extraction sites. The demand for sand to nourish eroding beaches has risen in recent time and will be expected to increase given the rising sea levels and eroding shorelines. Although the direct and indirect impacts are not completely understood, it is expected that benthic communities will be directly disturbed because of the extractive nature of the activity and because the dynamics of the water movement may be influenced which could have the potential to alter sediment dynamics. As for cumulative impacts, it is important to note that if the proposed action is permitted and constructed, sand and gravel extraction within the designated MMS lease area would be precluded.

Figure BA-14
Cumulative Impact Study Area

Presently, there is one proposal for an offshore sand mining project in the vicinity of Nantucket Sound. The Sconset Beach Nourishment Project is proposing a 345 acre (140 hectare) borrow site approximately 3 miles east of Nantucket Island outside of Nantucket Sound and just outside the Cape & Islands Ocean Sanctuary. This proposed action is currently under MEPA review and is contingent upon approval and licensing from several other state and federal agencies including the MMS and the ACOE.

There is also an expressed interest by the Town of Barnstable to conduct sand mining projects within Nantucket Sound in the vicinity of the proposed action for future beach nourishment. Although there are presently no approvals for sand mining projects by MMS, the potential for future sand mining activities and associated construction do exist. In the event that the proposed action and an offshore sand mining project occur concurrently in proximity, there is a potential risk for cumulative impacts to listed marine species associated with the proposed action and sand mining activities. However, as noted previously, if the proposed action is permitted, sand mining would be precluded within the designated MMS lease area.

Any impacts associated with the proposed action are expected to be localized and temporary and mitigation measures will be implemented to further reduce or eliminate the potential for impacts. In addition, as discussed earlier, Nantucket Sound is not considered a high use area for whales and sea turtles have only been occasionally observed in the Sound as transient species. If any listed whales or sea turtle species were to be present in the proposed action area, they would likely temporarily avoid the area during construction activities. These natural tendencies along with proposed action mitigation measures significantly reduce the impacts from the proposed action. If a sand mining Project were to occur concurrently with proposed action construction, the sand mining Project would have to occur outside of the MMS lease area (the 25 mi^2 [6475 hectare] proposed action area). Due to the geographical separation of the proposed action and any future sand mining project, cumulative impacts would be discountable or insignificant.

Because the proposed action has been sited and designed to avoid, minimize or mitigate potential impacts to protected marine species, any cumulative impacts from concurrent construction of the proposed action and a sand mining project are likely to be limited to those associated with the sand mining activities, with no significant adverse impacts taking place as a result of the proposed action.

6.2 Offshore Wind Projects

Aside from the proposed action, the only other offshore wind power installation that may have the potential to contribute to cumulative impacts to protected marine species is the Patriot Renewables, LLC proposed wind farm in the Cape and Islands Ocean Sanctuary of Buzzards Bay. No other offshore wind installations of any significant size have been proposed off the New England coast. Based on European experiences, each wind farm is expected to have relatively similar impacts on environmental resources although some discrepancies will arise given the differences in scale and location for each commercially-sized project. The potential cumulative impacts associated with the proposed action and the Patriot Renewables, LLC proposed project, if they were to be constructed and/or operated concurrently, are described below.

No significant cumulative impacts to listed species are expected from the construction and operation of the proposed action. Any impacts associated with the WTGs, the inner-array cables, or the two submarine cable circuits are expected to be localized and temporary. In addition, mitigation measures will be implemented to further reduce impacts (see Section 5.5 and Section 8.0). The Patriot Renewables, LLC project is similarly expected to have localized and temporary impacts and likely would also implement similar mitigation measures to that of Cape Wind. In addition, neither Nantucket Sound nor Buzzards Bay is considered a high use habitat for whales (Buzzards Bay Project National Estuary Program, 1991; Howes and Goehringer, 1996; Kenney and Winn, 1986) and sea turtles are transient species, occasionally observed in both Nantucket Sound and Buzzards Bay. Therefore, the rarity with which these listed marine species occur in these areas further reduces associated impacts. Individually, these projects are only expected to result in minimal localized and temporary impacts to listed whales and sea turtle species. Because the geographical separation of the two proposed projects is somewhere between 15 to 20 miles (24 to 32 km) apart, depending on which study area would be preferred for the Patriot Renewables, LLC project, the addition of the Cape Wind proposal would add only minor impacts cumulatively.

Potential cumulative effects may accrue for the Federally Endangered roseate tern or Federally Threatened piping plover as a result of the development of the Patriot Renewables, LLC wind farm. The proposed location of this facility in Buzzards Bay would be in proximity of the major Massachusetts roseate tern nesting colonies, including Bird and Ram Island, and Penikese Island. Buzzards Bay provides nesting habitat for 99 percent of Massachusetts breeding pairs and for 45- to 50 percent of North America's breeding pairs. Therefore, although the exact location of the Patriot Renewables project is unknown, it is reasonable to anticipate that, if constructed, it would have substantially greater impacts than the proposed action on roseate terns. Piping plover also nest along the mainland and island shorelines of Buzzards Bay. The cumulative effects for roseate tern and piping plover may include habitat modification, influences to flight behaviors, or increased collision mortality. Because of these potential impacts, the two projects combined do have the potential for at least moderate levels of cumulative impacts.

The MMA turbine has a maximum height of 74 m (243 ft) and is located at the western entrance of the Cape Cod Canal. The turbine is situated 100 m (328 ft) from the water's edge on a landmass adjacent to a popular common and roseate tern foraging location, the Mashnee Flats Shoal, located 5.3 miles (9 km) from Bird Island. Post-construction surveys indicate that the turbine has not presented a barrier to traveling terns as they have been observed to occur within the 50 m airspace of the turbine, with no apparent hindrances to their movements as they travel between foraging locations. No tern or shorebird mortalities were reported from the 2006 survey period. The turbine has resulted in no measurable impacts to avian species. Applying the results of the MMA turbine study to the prediction of impacts associated with the proposed action should be done with caution. The MMA turbine is a single structure that is land-based compared to the 130 proposed turbines that would be located offshore.

6.3 Other Offshore Power Projects

While it is possible that other energy project developers could pursue a generation site within or nearby Nantucket Sound and the proposed action area, only one tidal power project is currently known.

An application has been filed with FERC for a potential tidal power site in the area between Martha's Vineyard and Falmouth/Woods Hole. Construction and operation of a tidal power facility at this location would have cumulative effects on some of the resources also present at the Proposed Site. For instance, construction could result in noise, elevated turbidity, increased vessel activity, all of which would be temporary, but may result in avoidance behavior of the construction area by terns as well as sea turtles and whales. Given that there is likely to be a schedule difference of at least a year, if not more, this cumulative effect would not adversely affect the listed species.

Operation of the known tidal power project could result in some cumulative impacts over time, since some of the listed species would occur in both project areas, however, there is not enough information known about the tidal power project to predict or discuss these cumulative impacts for all species. However, the potential development of tidal power in the region may result in cumulative effects to avian species in the form of habitat modification or decreased breeding success. Disruptions to the dynamic sedimentation process of inter-tidal areas would result in changes to sediment and turbidity within potential foraging habitat. Avian species may suffer from indirect impacts due to changes of prey base in impacted areas. Impediments to foraging can result in increases in energy expenditure while bird species access alternative resources, as well as decreased breeding success.

6.4 Maintenance Dredging/Beach Nourishment

The submarine cable system for the proposed action would be placed adjacent to the eastern edge of the Federal Navigation Project in Hyannis Harbor. Maintenance dredging of the channel, if initiated at the same time as the jet plow installation of the cable system, could result in additional concurrent, cumulative sediment suspension and deposition and some mortality to benthic resources. Hyannis Harbor was dredged in 1985, 1991, 1998, and 1999. No future dredging activities are currently scheduled. Nonetheless, the potential for cumulative impacts to protected marine species resulting from Hyannis Harbor dredging activities possibly occurring concurrently with the jet-plow installation of the submarine cable system into Lewis Bay is discussed below.

As discussed in Report No. 4.1.1-2, sediment deposition resulting from proposed action's cable installation would be minimal and localized and would not substantially contribute to any cumulative impact. It is expected that the permits authorizing dredging in Hyannis Harbor would stipulate that proper measures be taken to avoid/minimize impacts during the dredging event. In addition, listed whale and sea turtle species are not considered common in the vicinity of Hyannis Harbor and, individually, these projects are not likely to result in impacts to whales or sea turtles. Although interactions between sea turtles and dredging activities have been documented, potential dredging of Hyannis Harbor will not likely occur simultaneously to the proposed action's submarine cable installation and Hyannis Harbor is not an area that has high reported observations of sea turtles. Therefore, the potential for cumulative impacts to occur to listed whale and sea turtle species from concurrent dredging and proposed action's cable installation is minimal.

Effects of dredging and beach nourishment activities on shorebirds and terns can be both positive and negative, and the effects appear to be situational. Dredging may change foraging habitat by re-releasing settled toxicants into the water and by altering predator dynamics in the region (Burger, 1995). Increased human presence during dredging can affect nesting and foraging tendencies of both terns and shorebirds (Burger, 1995). Dredging can also positively affect shorebirds by providing material for creation of habitat when deposed on land. However, in some cases, artificial and stabilized dunes and vegetation may impair avian nesting success by disrupting the natural processes of dune vegetative growth and sand accretion (USFWS, 1996). The erection of snow fencing to stabilize dunes may degrade nesting habitat (USFWS, 1996). In some cases, beach stabilization has led to the decrease of natural tidal inundations that create favored habitat for nesting piping plover (USFWS, 1996).

At sites throughout New England, New York, and New Jersey, beach nourishment has created habitat for piping plover (Burger, 1995; USFWS, 1996). Additionally, beach nourishment may cause the depletion of bird nesting habitat in nearby areas if the relocated sand becomes ultimately unavailable to the natural sand deposition processes that occur at other habitats in the area. The proper regulation of dredging and beach nourishment activities to benefit avian species of conservation concern is anticipated to mitigate the negative cumulative effects of such activities.

6.5 Commercial and Recreational Fishing

Commercial fishing and recreational fishing may result in effects to foraging terns. The roseate tern relies on American sandlance (*Ammodytes americanus*) for approximately 70 percent of its diet (Rock *et al.,* 2007). Studies suggest that declines in food availability are associated with the presence of schools of predatory bluefish (*Pomatomus saltatrix*) (Safina *et al*., 1988). The catch of large, predatory fish by the fishing industry may positively affect roseate tern by reducing competition for bait fish. Alternately, terns benefit from the presence of predatory fish that push bait fish to the surface where they become more available to foraging terns. Therefore, over fishing may result in negative effects to terns as well. However, terns also catch prey over the shallow water of shoals. Recreational fishermen are attracted to flocks of feeding terns as their presence usually indicates that predatory fish (bass or bluefish) are present. The reverse may also be true as terns and gulls are among species of birds that are believed to be attracted to fishing vessels, therefore, the presence of commercial and recreational fishing boats may attract terns to an area to forage (Borberg *et al.,* 2005; Drewitt and Langston, 2006; Sadoti *et al.,* 2005a). Commercial and recreational fishing do not have any effect on piping plover, and no significant negative or positive effects on roseate terns; therefore cumulative effects are expected to be discountable or insignificant.

6.6 Commercial Shipping/Vessel Collisions

Although oil tanker trips near the proposed action are infrequent, the presence of WTG and ESP foundations in the vicinity of oil tanker shipping lanes increases the risk of ship collisions, and possibly oil spills. The contents of tankers may be released, or fluids contained within the ESP or WTG structures could be released. The likelihood of an oil spill as it relates to the proposed action is drastically reduced due to the minimal shipping traffic that takes place in the vicinity of HSS. As noted in Section 4.4.3 of the DEIS, Nantucket Sound is not a main thoroughfare for commercial shipping, as through Buzzards Bay and the Cape Cod Canal. In addition, the DEIS notes, "The location of the site of the proposed action relative to established vessel routes, physical water depth restrictions on HSS and the large WTG grid spacing combine to limit the potential for a vessel to collide with a WTG."

Because terns forage at the water's surface, they are among those species of birds that are particularly vulnerable to oil spills (Jarvis, 2005). Depending on the location of the effected area of a spill, shorebird habitat may be impacted. If the feathers become coated with oil, birds loose their ability to repel water and to insulate, and in some instances, loose the ability to fly. Potential impacts include mortality from heat loss, starvation, or drowning. Mortality can result if toxins are ingested through water or during preening. Also, nesting birds can transfer oil to their eggs resulting in decreases in hatching success, developmental problems, or the mortality of embryos (Jarvis, 2005).

The potential cumulative effects of oil spills associated with the proposed action would be situational depending on the location and size of the area affected by a potential spill. Large spills or spills that are not quickly contained could result in the mortality of terns or shorebirds, or could lead to decreased nesting success. Oil spills could directly impact roseate tern colonies or piping plover nesting habitat as occurred in 2003. However, due to the distance of the proposed action from nesting locations, and the fact that oil spills are unlikely events, oil spills associated with the proposed action are expected to result in discountable or insignificant cumulative impacts.

6.7 Military Operations

Military operations in the proposed action area are minimal, and none occur that are likely to have adverse affects on listed species.

6.8 Bird Collisions with Human Structures

There is the potential for avian cumulative effects in the form of collision mortality associated with other tall, man-made structures. The results of mortality surveys indicate that birds killed by communication towers are mainly neotropical migratory songbirds. The majority of collisions of migratory songbirds appear to occur at night when they may become disoriented by required navigational lights on towers, particularly during inclement weather (Shire *et al.*, 2000). The U.S. Fish and Wildlife Service estimates that 4 to 5 million birds are killed annually at communication towers (Shire *et al.,* 2000). Over 200 species of birds have been documented to die as a result of collision with communication structures. A summary of 47 mortality studies conducted in the U.S. indicates that tern, gull, and petrel species represent 2 percent of tower collision fatalities; and shorebird species represent 5 percent of documented mortality. Roseate terns may be susceptible to collisions with land-based man-made structures including communication towers and lighthouses as they will travel as far as 16 to 19 miles (25 to 30 km) from the breeding colonies to access foraging habitat (Heinemann 1992), and some of their movements result in crossings of sections of land. However, there is a lighthouse on Bird Island, one of the most important colony sites in the region, and the lighthouse has resulted in no major adverse impacts to the nesting terns. However, this lighthouse is less than 40 ft (12 m). A roseate tern was suspected to collide with this tower during a storm in May 2006 (Causey and Mostello, 2006). Additionally, this lighthouse has served as a perch for peregrine falcons while hunting terns (USFWS, personal communication). However, roseate terns have habituated to this structure over time and therefore, risk of collision with this structure may not be relevant to the substantially larger structures proposed for the action area that would be, at first, unfamiliar to the terns. Outside of migration, piping plover are less susceptible to collision with land-based structures as the majority of their movements are small-scale between nesting areas and inter-tidal zones.

Lighthouses are among the first man-made structures known to result in avian collision mortality (Jones and Francis, 2003). Photopollution associated with lighthouse beams can have detrimental effects on the navigation systems of insects, sea turtles, and birds (Jones and Francis 2003). Collisions with lighthouse structures may occur, particularly during cloudy or foggy conditions; disoriented migrants may also die as a result of exhaustion after circling light sources; and migrants may also become more susceptible to predation after expending energy to circle around a light source (Jones and Francis, 2003). A study on the impacts to migrants posed by a lighthouse in on Lake Erie in Ontario documented up to 2000 bird kills in a single night. Neotropical migratory songbirds consisted of the majority of collisions. However, after altercations to the light beam (decreasing the intensity and narrowing the beam) the kill rate decreased.

Terns and shorebirds are among species of birds that have experienced relatively low collision mortality with other man-made structures. Therefore, the cumulative impacts associated with additional collision mortality due to other man-made structures are anticipated to be discountable or insignificant.

6.9 Coastal Development

Coastal development has contributed to the population declines of both roseate tern and piping plover. Residential and commercial development decreases suitable habitat for these species while increasing disturbances associated with human presence in the area. Of particular concern is the construction of hardened structures, including jetties, piers and groins, designed to impede natural variability in inter-tidal zones. Studies have found that shorebirds, including the piping plover, rely on many of the characteristics of a volatile coastal environment including over-wash fans, sand pits, open vegetation, and ephemeral pools for nesting and foraging habitat (USFWS, 1997; Houghton, 2005). Loss of sand accretion during natural offshore drift processes due to artificial beach barriers may result in the erosion of habitat, therefore, such coastal development is directly related to habitat modification or loss. Alternately, artificial beach barriers such as jetties may result in the creation of habitat on the up-drift side of an artificial structure (USFWS, 1996). However, excessive sand accretion may result in vegetative growth that may eventually make habitat less suitable to piping plover. Continued management efforts to maintain or restore habitat, the creation of additional nesting habitat, and the regulation of additional development activities are anticipated to mitigate the cumulative effects of coastal development.

6.10 Coastal Recreational Activities

Human recreation in coastal areas results in disturbances to breeding or staging shorebirds and terns. Human disturbances may result in increased energy expenditure or decreased nesting success for avian species. Piping plovers, for example, have been shown to choose nesting and foraging habitat of sub-optimal quality to avoid nesting in areas with a relatively high human presence. Piping plovers will permanently abandon nest due to significant levels of disturbance. Terns may abandon their nests in the presence of humans, leaving eggs or chicks vulnerable to chilling or predation (USFWS, 2001).

Where permitted, the use of motor vehicles on beaches has negative impacts on foraging and nesting shorebird and tern species. Motorized vehicles can crush eggs and chicks, cause noise pollution, damage breeding or foraging habitat, create ruts that disrupt foraging patterns and trap chicks, and can scare brooding adults away from their nests leaving eggs vulnerable to cooling as well as predation (USFWS, 1996). However, management practices are geared to minimizing the impacts of human activities at important nesting areas. Efforts include fencing and signs and the restriction of access of pedestrians and vehicles from breeding areas between the period of hatching to fledging. Management activities are expected to mitigate the negative cumulative effects of human coastal recreational activities.

7.0 EFFECTS DETERMINATION FOR LISTED SPECIES AND DESIGNATED CRITICAL HABITATS

Though there is potential for adverse impacts on the listed species from project actions, these impacts will be mainly temporary and localized to the vicinity of the area of the proposed action. Long-term impacts may occur if certain species avoid the habitat previously used in HSS, however, this would be minor given HSS is not a critical foraging or resting habitat for listed species. No actions are expected to be lethal for listed whales or sea turtles described in this report. The extent of any impacts of project actions is further reduced in that those whales and sea turtles described are rarely observed in the vicinity of the proposed action, and any occurrence is presumed to be transient and temporary.

The greatest risks are posed by acoustical harassment and water quality degradation. Increased noise levels due to pile driving and jet plowing are expected to result in only minor impacts to both whales and sea turtles, primarily resulting in the temporary and perhaps permanent avoidance of the area where construction is occurring. Once construction ceases, it is expected that the whales and sea turtles will resume their normal activities in the area of the proposed action, although this is unknown. Table 6 provides a summary of the determination of effect for each of the listed species covered in this Biological Assessment.

Regarding the piping plover, the results of collision probability modeling suggest that collision mortality associated with the proposed action would result in a moderate adverse impact. Although the level of collision mortality associated with the proposed action is anticipated to be low, there is great uncertainty surrounding piping plover use of the project area. With respect to the roseate tern, available data suggest a low level of risk of collision with WTG structures. However, there is uncertainty surrounding the available data. The loss of a single breeding individual would be detrimental to the regional population; therefore, a moderate adverse impact to the roseate terns is anticipated.

Table 6.
Effects Determination Summary

Group	Common Name	Effect Determination	Basis
Whale	Fin	May affect, but not likely to adversely affect	Frequency of occurrence in the proposed action area is extremely low. Proposed action vessels will be relatively slow moving. Effects of disturbance within HSS unlikely to influence higher use areas outside of Nantucket Sound
	North Atlantic Right	May affect, but not likely to adversely affect	Frequency of occurrence in the proposed action area is extremely low. Proposed action vessels will be relatively slow moving. Effects of disturbance within HSS unlikely to influence higher use areas outside of Nantucket Sound

Table 6.
Effects Determination Summary

Group	Common Name	Effect Determination	Basis
	Humpback	May affect, but not likely to adversely affect	Frequency of occurrence in the project area is extremely low. Proposed action vessels will be relatively slow moving. Effects of disturbance within HSS unlikely to influence higher use areas outside of Nantucket Sound
Sea Turtle	Leatherback	May affect, but not likely to adversely affect	Frequency of occurrence in the project area is extremely low. Proposed action vessels will be relatively slow moving. Effects of disturbance within HSS unlikely to influence higher use areas outside of Nantucket Sound
	Green	May affect, but not likely to adversely affect	Frequency of occurrence in the proposed action area is extremely low, and they tend to be in shallow waters with seagrasses. Effects of disturbance within HSS unlikely to influence higher use areas outside of Nantucket Sound.
	Loggerhead	May affect, but not likely to adversely affect	Feeds on benthic fouling organisms likely to develop on monopiles and rock scour armor so could be attracted to WTGs where they could experience greater interaction with maintenance vessels and recreational fishermen. One of the more common sea turtles in the area so more potential for interaction with construction and operation vessels.
	Kemp's ridley	May affect, but not likely to adversely affect	Feeds on benthic organisms likely to develop on monopiles and rock scour armor. One of the more common sea turtles in the area so more potential for interaction with construction and operation vessels.
Bird	Piping Plover	May adversely affect	A level of collision mortality associated with the proposed action is speculated. There is uncertainty in the available information, and in the predictions of collision mortality. The loss of a single individual piping plover is considered an adverse impact.

Table 6.
Effects Determination Summary

Group	Common Name	Effect Determination	Basis
	Roseate Tern	May adversely affect	A level of collision mortality associated with the proposed action is speculated. There is uncertainty in the available information, and in the predictions of collision mortality. The loss of a single individual roseate tern is considered an adverse impact.

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 and birds. Any additional mitigation, monitoring or reporting measures may be added during the Federal ESA Section 7 process or through any issued MMS leases or other authorizations.

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 whales and sea turtles. They are divided into the 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 ultimately be required through the ESA consultation process will be included as requirements in any MMS lease or other authorization, if issued, for the proposed activity.

The applicant has informed MMS that it intends to seek authorization from NMFS under the MMPA. Therefore, MMS will require that the MMPA authorization be completed and a copy provided to MMS before activities are allowed to commence under any MMS issued lease or other authority that may result in the taking of marine mammals. This also includes any amended ESA incidental take statement, if issued, to include marine mammals. Any measures contained within any MMPA authorization, if issued, that are more conservative than those measures built into this proposed action will take precedence.

8.1.1 Requirements for All Phases of Project

As noted in Section 2.3 of the DEIS, the construction phase of the proposed action will temporarily increase the number of vessels within the vicinity of the construction area, especially in the route between Quonset, Rhode Island and the proposed action area. Several shipping lanes and two navigational channels exist within the vicinity of the proposed action area, 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 proposed action site. 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 additional traffic from construction vessels may increase the chance of a strike or harassment of marine mammals or sea turtles.

Sections 2.3, 2.4 and 2.5 of the DEIS provides detail on the vessel and aircraft activity associated with the operations/maintenance and decommissioning phases of the project.

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

- All vessels and aircraft associated with the construction, operation/maintenance and/or decommissioning of the project will be required to abide by the: (1) 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); and (2) MMS 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).

- All vessel and aircraft operators must undergo training to ensure they are familiar with the above requirements. These training 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 MMS Gulf of Mexico Region's NTL No. 2007-G03 (http://www.gomr.mms.gov/homepg/regulate/regs/ntls/2007NTLs/07-g03.pdf). MMS will not require the applicant to undergo formal training or post placards, as described under this NTL. The applicant will be required to 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 Geophysical Surveys

Section 2.7 of the DEIS describes the marine shallow hazards surveys and geotechnical program the applicant would undertake should MMS issue a lease for the proposal. These geophysical and geotechnical (G&G) 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 seismic surveying work proposed by the applicant. Additional detail on how these measures will be implemented is described in the MMS Gulf of Mexico (GOM) Notice to Lessee (NTL) No. 2007-G02 (see http://www.gomr.mms.gov/homepg/regulate/regs/ntls/2007NTLs/07-g02.pdf). Although this NTL focuses on seismic surveying with air guns in the GOM, the methodologies described in the NTL for exclusion zone monitoring, ramp up and shut down as the same as those that will be required under this proposed action.

- *Establishment of Exclusion Zone*: A 250 m (820.2 ft) radius exclusion zone for listed whales 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*: The exclusion zone around the seismic survey source vessel must be monitored for the presence of listed whales or sea turtles before, during and after any pile driving activity. The exclusion zone will be monitored for 30 minutes prior to the ramp up (if applicable) of the seismic survey sound source. If the exclusion zone is obscured by fog or poor lighting conditions, surveying will not be initiated until the entire exclusion zone is visible for the 30 minute period. If listed whales or sea turtles are observed within the zone during the 30 minute period and before the ramp up begins, surveying will be delayed until they move out of the area and until at least an additional 30 minutes have passed without a listed whale or sea turtle sighting. Monitoring of the zone will continue for 30 minutes following completion of the seismic surveying.

  Monitoring of the zones will be conducted by one qualified NMFS approved observer[3]. 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 whales or sea turtles will be transmitted to NMFS and MMS within 48 hours. Any observed takes of listed whales or sea turtles resulting in injury or mortality will be immediately reported to NMFS and MMS.

- *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 by allowing them 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. However, if a listed whale 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 will only be allowed following clearance of the exclusion zone and the implementation of ramp up procedures (if applicable).

- *Compliance with Equipment Noise Standards*: All seismic surveying equipment will comply as much as possible with applicable equipment noise standards of the U.S.

[3] Observer qualifications will include direct field experience on a marine mammal/sea turtle observation vessel and/or aerial surveys in the Atlantic Ocean/Gulf of Mexico. All observers will receive NMFS-approved marine mammal observer training and be approved in advance by NMFS after a review of their qualifications.

Environmental Protection Agency, and all equipment will have noise control devices no less effective than those provided on the original equipment.

- *Reporting for Seismic Surveys Activities*: The following reports must be submitted during the conduct of seismic surveys:

  - A report will be provided to MMS 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 whales 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 whale or sea turtle sightings (dates, times, locations, activities, associated seismic activities), and estimates of the amount and nature of listed whale or sea turtle takings.

  - Any observed injury or mortality to a listed whale or sea turtle must be reported to NMFS and MMS within 24 hours of observation. Any significant observations concerning impacts on listed whales or sea turtles will be transmitted to NMFS and MMS within 48 hours.

8.1.3 Requirements During Construction

Acoustic harassment from construction activities hold the greatest potential for disturbance and impacts to listed whales and sea turtles due to the size and number of piles and the timeframe needed to complete the installation of all piles. Section 2.5.1 of the BA and Sections 2.3.2.2 of the DEIS describe the pile driving process in detail. Section 5.0 of the BA and Sections 5.3.2.9.1 of the DEIS outline the potential effects of pile driving activities on listed whales and sea turtles.

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

- *Pre-Construction Briefing*: Prior to the start of construction, a briefing will be held between the construction supervisors and crews, the marine mammal and sea turtle visual and acoustic observer(s) (see further below), and Cape Wind Associates. The purpose of the briefing will be to establish responsibilities of each party, define the chains of command, discuss communication procedures, provide an overview of monitoring purposes, and review operational procedures. The Resident Engineer will have the authority to stop or delay any construction activity, if deemed necessary. New personnel will 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 turbine monopile and Electrical Service Platform (ESP) installation:

- Establishment of Exclusion Zone: A preliminary 750 m (2,461 ft)[4] radius exclusion zone for listed whales and sea turtles will be established around each pile driving site in order to reduce the potential for serious injury or mortality of these species. Once pile driving begins, the actual generated sound levels will be measured (see requirements below for *Field Verification of Zone*) and a new exclusion zone will be established based on the results of these field-verified measurements. This new exclusion zone will be based on the field inputs calculating the actual distance from the pile driving source where underwater sound levels are anticipated to equal or exceed 180 dB re 1 microPa rms (impulse). Based on the outcome of the field-verified sound levels and the calculated or measured distances as noted above, the applicant can either: (1) retain the 750 m zone or (2) establish a new zone based on field-verified measurements demonstrating the distance from the pile driving source where underwater SPLs are anticipated to equal or exceed the received the 180 dB re 1 microPa rms (impulse). 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 180 dB zone and be approved by MMS and NMFS before implementing. Once approved, this zone will be used for all subsequent pile driving and will be periodically re-evaluated based on the regular sound monitoring described in the *Field Verification of Exclusion Zone* section described below.

- Field Verification of Exclusion Zone: Field verification of the exclusion zone will take during pile driving of the first three piles. The results of the measurements from the first three piles can then be used to establish a new exclusion zone which is greater than or less than the 750 m depending on the results of the field tests.

Acoustic measurements will take place during the driving of the last half (deepest pile segment) for any given open-water pile. One reference location will be established at a distance of 100 m (328 ft) from the pile driving. Sound measurements will be taken

[4] Underwater sound pressure levels measured during impact pile driving to install the monopiles for the Utgrunden Wind Park in Sweden were used to derive the pile driving root mean square (RMS) sound level for the Cape Wind Project because the size of the monopiles and the installation techniques are similar. The RMS sound pressure level at 500 meters is 177.8 dB re 1 μPa for Utgrunden. The monopile diameters for the Cape Wind project, 5.1 to 5.5 meters, are slightly larger than monopiles for Utgrunden, and the cross-sectional area is 60 percent larger. Assuming pile driver blow energy (E) scales by the cross-sectional area and impulse noise is proportional to $10*\log(E_2/E_1)$ when blow energy increases from E_1 to E_2, the RMS sound pressure level for Cape Wind scales up to 179.8 dB re 1 μPa at 500 meters averaged over a 125-millisecond pulse duration. The SEL for Cape Wind also scales up in the same manner to 173 dB re 1 μPa at 500 meters. A recent COWRIE report suggests underwater SEL values of 171-173 dB re 1 μPa at 500 meters for piles with diameters equal to those proposed for Cape Wind (Nehls et al., 2007). Thus, the sound source data for Cape Wind are validated by recent COWRIE data at other wind farms. In order to apply an initial exclusion zone size that conservatively allows for an area that will avoid potential Level A harassment of marine mammals, MMS has established a preliminary 750-m zone. However, the applicant has the option to conduct field verification of this zone, as noted above, and change the size of the zone based on these measurements.

at the reference location at two depths (a depth near the mid-water column and a depth near the bottom of the water column but at least 1 m (3 ft) above the bottom) during the driving of the last half (deepest pile segment) for any given pile. Two additional in-water spot measurements will be conducted at appropriate depths (near mid water column), generally 500 m (1,640 ft) and 750 m (2,461 ft) in two directions either west, east, south or north of the pile driving site. These will be conducted at the same two depths as the reference location measurements. In cases where such measurements cannot be obtained due to obstruction by land mass, structures or navigational hazards, measurements will be conducted at alternate spot measurement locations. Measurements will be made at other locations either nearer or farther as necessary to establish the approximate distance for the zones. Each measuring system shall consist of a hydrophone with an appropriate signal conditioning connected to a sound level meter and an instrument grade digital audiotape recorder (DAT). Overall SPLs shall be measured and reported in the field in dB re 1 micro-Pa rms (impulse). An infrared range finder will be used to determine distance from the monitoring location to the pile. The recorded data will be analyzed to determine the amplitude, time history and frequency content of the impulse.

- Visual Monitoring of Exclusion Zone: Visual monitoring of the exclusion zone will be conducted during driving of all piles. Monitoring of the zones will be conducted by one qualified NMFS approved observer[5]. Multiple monitors will be required if pile driving is occurring at multiple locations at the same time.

  Observer(s) will begin monitoring at least 30 minutes prior to soft start of the pile driving. Pile driving will not begin until the zone is clear of all listed whales and sea turtles for at least 30 minutes. Monitoring will continue through the pile driving period and end approximately 30 minutes after pile driving is completed.

  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 whales or sea turtles will be transmitted to NMFS and MMS within 48 hours. Any observed takes of listed whales or sea turtles resulting in injury or mortality will be immediately reported to NMFS and MMS.

[5] Observer qualifications will include direct field experience on a marine mammal/sea turtle observation vessel and/or aerial surveys in the Atlantic Ocean/Gulf of Mexico. All observers will receive NMFS-approved marine mammal observer training and be approved in advance by NMFS after a review of their qualifications.

- Required Mitigation Should Listed Whales or Sea Turtles Enter the Exclusion Zone: The exclusion zone around the pile driving activity must be monitored for the presence of listed whales or sea turtles before, during and after any pile driving activity. The exclusion zone will be monitored for 30 minutes prior to the soft start of pile driving. If the safety radius is obscured by fog or poor lighting conditions, pile driving will not be initiated until the entire safety radius is visible for the 30 minute period. If listed whales or sea turtles are observed within the zone during the 30 minute period and before the soft start begins, pile driving of the segment will be delayed until they move out of the area and until at least an additional 30 minutes have passed without a listed whale or sea turtle sighting. Monitoring of the zone will continue for 30 minutes following completion of the pile driving activity.

  MMS recognizes that once the pile driving of a segment begins it cannot be stopped until that segment has reached its predetermined depth due to the nature of the sediments underlying the Sound. 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 whales and sea turtles, as they would endure potentially higher SPLs for longer periods of time. Pile segment lengths and wall thickness have been specially designed so that when work is stopped between segments (but not during a single segment), the pile tip is never resting in highly resistant sediment layers. Therefore, because of this operational situation, if listed whales or sea turtles enter the zone after pile driving of a segment has begun, pile driving will continue and observers will monitor and record listed whale and sea turtle numbers and behavior. However, if pile driving of a segment ceases for 30 minutes or more and a listed whale 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 be started 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 MMS 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” will be required at the beginning of each pile installation in order to provide additional protection to listed whales 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 whales 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) will delay pile-driving until the animal has moved outside the exclusion zone.

- Compliance with Equipment Noise Standards: All construction equipment will comply as much as possible with applicable equipment noise standards of the U.S. Environmental Protection Agency, and all construction equipment will 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:

  - Prior to any re-establishment of the exclusion zone, a report must be provided to MMS and NMFS detailing the field verification measurements and proposal for the new exclusion zone. 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. Any new zone may not be implemented until MMS and NMFS have reviewed and approved any changes.

  - Weekly status reports will be provided to MMS and NMFS that include a summary of the previous week's monitoring activities and an estimate of the number of listed whales 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 whale or sea turtle sightings (dates, times, locations, activities, associated construction activities), and estimates of the amount and nature of listed whale or sea turtle takings. NMFS and MMS may reduce or increase the frequency of this reporting throughout the time period of pile driving activities dependent upon the outcome of these initial weekly reports.

  - Any observed injury or mortality to a listed whale or sea turtle must be reported to NMFS and MMS within 24 hours of observation. Any significant observations concerning impacts on listed whales or sea turtles will be transmitted to NMFS and MMS within 48 hours.

  - A final technical report within 120 days after completion of the pile driving and construction activities will be provided to MMS and NMFS that provides full documentation of methods and monitoring protocols, summarizes the data recorded during monitoring, estimates the number of listed whales and sea turtles that may have been taken during construction activities, and provides an interpretation of the results and effectiveness of all monitoring tasks.

- *Requirements for Cable Laying*: The following measures will be implemented during the conduct of cable laying activities:
    - The applicant must contact NMFS and MMS within 24-hours of the commencement of jet plowing activities and again within 24-hours of the completion of the activity.
    - All interactions with listed whales or sea turtles during cable laying activities must be reported to NMFS and MMS within 24 hours.
    - A final report must be submitted to NMFS and MMS within 60 days of completing cable laying activities which summarizes the results and any takes of listed species.

8.1.4 Requirements During Operation/Maintenance

Nedwell *et al.* (In press) measured and assessed the underwater noise and potential impacts to marine life during the construction and operations/maintenance phases of four offshore wind parks located in U.K. waters. For the operations/maintenance phase, they concluded that in general the level of underwater noise from the operation of a wind facility was very low and not above ambient levels even in close proximity to the turbines. Therefore, the underwater noise from the operation of offshore wind farms was unlikely to result in any behavioral response for the marine mammals and fish assessed in this study.

Given these results, the main mitigation required for the operations/maintenance phase of the proposed project, including standard and major repairs, inspections, etc. of the turbines, submarine cable and ESP, will include the vessel and aircraft measures outlined in section 8.1.1 of this BA. Section 2.4 of the DEIS outlines the anticipated vessel activity during the operations/maintenance phase of the proposal.

A yearly status report will also be provided to MMS that includes a summary of the year's operation and maintenance activities. In addition, any observed injury or mortality to a listed whale or sea turtle must be reported to NMFS and MMS within 24 hours of observation. Any significant observations concerning impacts on listed whales or sea turtles will be transmitted to NMFS and MMS within 48 hours.

8.1.5 Requirements During Decommissioning

Section 2.5.3 of the BA and Section 2.5.1 of the DEIS contain detail on the proposed methodology for decommissioning and removal of the wind turbines. 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.

The applicant would be required to remove all project components once operations have ceased and must provide a financial instrument or other assurances which secure this obligation. Monopiles would be removed by cutting from the inside at approximately 15 feet below grade. Depending on the capacity of the available crane, the monopile may be cut once or may be cut into several pieces. Cutting of the piles would be done using one or a combination of: underwater acetylene cutting torches, mechanical cutting, or high pressure water jet.

The applicant is required to submit a decommissioning plan to MMS for approval which satisfactorily demonstrates the removal and recycling of equipment and associated materials thereby returning the area to pre-existing conditions. MMS will then approve or disprove the plan based on the best information on available at the time (i.e., advances in cutting technologies or the development of new technologies with less of an environmental footprint). MMS will consult with NMFS prior to approval of this plan to ensure the plan's components are covered under any ESA biological opinion issued on this project and that any additional mitigation and monitoring measures are identified and implemented.

8.2 Measures for ESA-Listed Birds

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 on the proposed project (i.e., construction, operations/maintenance, decommissioning). They are divided into three sections: (1) compensatory mitigation; (2) mitigation specific to the design and operation of the project; and (3) monitoring and reporting requirements for project impacts. These measures, and those that may ultimately be required through the ESA consultation process, will be included as requirements in any MMS authorization, if issued, for the proposed activity.

8.2.1 Compensatory Mitigation

In accordance with requirements in the Massachusetts Environmental Policy Act (MEPA) Certificate, issued by the State of Massachusetts (via MassWildlife) on March 29, 2007, a $10M mitigation fund was established to compensate for unavoidable impacts to affected wildlife and habitat. On March 20, 2008, the MassWildlife provided MMS with a listing of the roseate tern and piping plover projects that would be implemented through this state run mitigation fund. This is in addition to the $780,000 already committed from this fund to be put toward restoration of Bird Island (described below), a significant nesting site for roseate terns. The details of this required compensatory mitigation, which are considered part of the proposed action, are described below.

- Bird Island Restoration: Under the Bird Island Restoration Project, funded in large part and carried out by the Army Corp of Engineers, approximately 2.2 acres of suitable roseate tern nesting habitat will be created or stabilized. This habitat restoration project will stabilize the shorefront and attenuate wave energy, provide new sand to renourish the eroded and scoured areas of the island, further protect the island from all but extreme storm waves and significantly reduce the rate of erosion. Ultimately, the project will create suitable nesting habitat for common tern thereby reducing the encroachment of this species into roseate tern nesting habitat. The restoration plan also provides mitigation for construction impacts to just over one-half acre of existing salt marsh resources on the island. The applicant, through the state-administered mitigation fund, has committed to provide $780,000 toward the overall project cost. The CD accompanying this formal consultation package contains a copy of the applicant's report on their contributions to the Bird Island Restoration project, including their estimates of the overall increases in roseate tern population numbers as a result of this project.

- Predator Management: MassWildlife plans to assign portions of the mitigation fund for contracts with the USDA-Wildlife Services to assess mammalian and avian predators at a carefully selected subset of priority Piping Plover nesting sites and at the three island-nesting colonies of Roseate and Common Terns in Buzzards Bay and to remove selected predators from those sites during winter and spring in order to improve plover and tern reproductive success and adult survival. Predator removal at priority plover nesting sites would likely benefit Least Terns as well. Predator removal work would be conducted pursuant to depredation permits issued by MassWildlife, and would occur only at sites where MassWildlife and USDA-Wildlife Services have secured permission from the landowner(s).

- Population Monitoring, Site Protection, and Management (Breeding Season): Funding would be used to sustain and augment current statewide efforts to monitor the abundance, distribution, and reproductive success of Piping Plovers and terns in Massachusetts and to protect the birds, their nests, unfledged chicks, and habitat from human recreational activities, dune-building and beach stabilization activities. Funding may be used to hire seasonal shorebird monitors directly through MassWildlife, or to contract with municipal or private conservation organizations (NGOs) to continue or augment current monitoring and protection activities as coordinated by MassWildlife and USFWS. Monitors will be expected to follow monitoring and management protocols as directed by MassWildlife, including reporting of abundance, reproductive success, and limiting factors using standard census forms; protection of nests, nesting habitat, and chick refuge areas with warning signs and string fencing; and protection of nests with wire predator exclosures. Priority locations where additional monitoring and protection for Piping Plovers is needed, and number of additional seasonal staff needed (in parentheses), are: Outer Cape (2), Upper Cape (1), Upper Cape / South Shore (1), Martha's Vineyard (1), Nantucket / Tuckernuck / Muskeget (1). Priority locations where additional tern monitoring and protection is needed, and number of additional seasonal staff needed (in parentheses), are: Buzzards Bay (1), Lower Cape (1).

- Identification and Protection of Tern and Piping Plover Post-Breeding Staging and Migration Areas (e.g., Signage, Patrolling, Education): Funding would be used to identify post-breeding staging and migratory stopover areas for terns and Piping Plovers, identify management needs, and then provide annual site management to protect the birds from human disturbance (purchase and install signage, patrol key staging sites, educate beach-goers, work with landowners and beach managers to reduce disturbance from dogs). An estimated four seasonal staff persons are needed to manage key sites statewide.

- Coastal Waterbird Conservation Assistant: Time dedicated to Piping Plover and tern conservation efforts by MassWildlife staff (now primarily the Senior Zoologist and Buzzards Bay Tern Restoration Coordinator) has actually declined over the past 6 years, at the same time that conservation needs have increased. Funding will be used to develop a new, year-round Costal Waterbird Conservation Assistant to oversee the scope and effectiveness of the statewide conservation efforts for Piping Plovers and terns.

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

MMS recognizes the inherent challenges in identifying the most effective monitoring plan to adequately assess project impacts to roseate terns and piping plovers. MMS also recognizes that for an effective monitoring plan to be developed for the proposed project, it will take input from a collective set of avian experts as well as MMS staff and the applicant. Therefore, MMS has required the applicant to develop a draft "Avian Monitoring and Reporting Plan" (AMRP) (See Appendix B to BA). This version of the plan is meant to monitor for any project impacts to ESA-listed avian species found in Nantucket Sound.

MMS ultimately intends for this draft plan to be expanded to cover non-ESA listed avian species. Before being finalized, the draft plan will be vetted by MMS through a set of experts selected by MMS for their knowledge of avian species or monitoring methods and technologies. This review team will include expertise on ESA-listed bird species (e.g., roseate terns, piping plovers and red knots (candidate species)) and will also have representation from FWS ESA consultation staff.

MMS intends to finalize this plan before completing the Record of Decision on project approval or disapproval so that this information can be considered in that decision. However, finalization of this plan will likely not occur during the ESA consultation period (i.e., 90 days from initiation of formal consultation). Therefore, for the purposes of this ESA consultation, the draft plan as attached and the mitigation measures contained in this BA should be considered as the baseline mitigation, monitoring and reporting requirements built into the proposed action. Should the separate finalization of the AMRP alter the contents of the draft plan, MMS will report and obtain concurrence from the FWS that any changes to these measures are consistent with the information considered, conclusions and reasonable and prudent measures contained in the FWS biological opinion.

The following additional mitigation measures represent requirements which would be implemented in an MMS lease, if issued, for the proposed project. These measures are directly related to requirements for the wind facility structures.

- Anti-Perching: The use of perch deterrent devices has discouraged terns perching on the fence and deck of the platforms supporting the Cape Wind Scientific Measurement Devices (SMDS). A study conducted in California to investigate the effectiveness of wire and wire screen perch guards estimated a 54 percent reduction in avian perching on turbines (Nelson and Curry 1995 *as cited by* NWCC and Rectenwald, 2007). In addition, the applicant's use of tubular towers instead of lattice towers would also discourage perching under the rotors. Dooling (2002) suggests that birds may be able to acoustically detect operating turbines, allowing them to avoid encounters with turbines.

In order to further minimize the potential for above water foundations to serve as perching habitat for birds, the applicant has proposed the use of the anti-perching devices as outlined in Section 2.2 of the attached draft Avian Monitoring and Reporting Plan (see Appendix B to BA). The applicant plans to test portions of the mechanism pre-construction. In addition, the applicant proposes to monitor the effectiveness of this anti-perching mechanism twice a month during May, June and July (higher tern abundance) for two years as well as install a monitoring camera on the helipad for remote viewing on a more frequent basis. For the first year of the project, MMS will require monthly reports on the results of the perching monitoring when listed avian species are potentially present in the action area (April-October). Frequency of monitoring for the second year will depend on the level of perching that was detected in the first year. In addition, based on the review panel's review of the AMRP (see below), monitoring may be required by MMS in subsequent years.

Should MMS, in consultation with the FWS, determine that the reporting results indicate enough perching behavior of concern is occurring, MMS will require the applicant to adjust the anti-perching mechanism. Any changes will be approved by MMS, in consultation with the FWS, and be based on best available information at that time and consider the mechanisms outlined in Section 2.3.3 of the AMRP. The level of monitoring then required for any new mechanism will be determined at the time of implementation of that mechanism.

- Lighting: There is a concern that the 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 avian collisions with communication towers reported in the U.S. (Shire *et al*., 2000). A large scale mortality event at a wind farm was believed to be associated with sodium vapor lighting of nearby substation (Kerns and Kerlinger, 2004). After these lights were no longer used, no other large scale mortality events were reported. Emerging data from existing onshore wind farms in the U.S. suggest that FAA required lighting on wind turbines does not increase avian risk of collision. Available studies indicate no significant trends between mortality at lit turbines verses unlit turbines (Erickson *et al.,* 2004; Jain *et al*., 2007; Arnett *et al*., 2005). The substantially higher numbers of fatalities observed at lit communication towers (at heights greater than 305 m [1,000 ft]) in the U.S. may be influenced by the greater heights of the towers, the guy wires, or the steady-burning lights mounted on many towers (Jain *et al.,* 2007), versus the flashing lights on wind turbines.

In compliance with the new Federal Aviation Administration (FAA) guidelines and U.S. Coast Guard (USCG) navigational safety lighting requirements, the 50 perimeter WTG nacelles and the 8 WTGs located adjacent to the ESP would be lit at night. Every other perimeter WTG would be lit by a single, medium intensity red light at night, with each alternating perimeter WTG lit by a single, low intensity red light. The red lights on the perimeter WTGs would be synchronized to flash in unison. The red lighting would flash on for one second, followed by no flashes for two seconds. The remainder of the 72 interior WTGs would not be lit with red lighting at night. Two USCG amber navigation warning lights would be also installed on the access platforms of each tower approximately 32 feet above the water's surface. Helicopter navigational lights will be remotely activated on the helipad as needed. Construction structures and equipment would be lit at night. In addition, MMS will require that the applicant leave lights on only when necessary and downshield when possible, including onshore security and equipment lighting and support vessel lighting.

- <u>Additional Mitigation, Monitoring and Reporting Measures in Response to Results of AMRP</u>: The final, approved AMRP will serve as the basis for monitoring and reporting information on the use of the action area by listed avian species. MMS will use this information to then determine whether there is significant use of the project site by listed avian species flying at heights that could incur a risk of collision. Significance will be evaluated by MMS in consultation with the FWS. If significance is determined, MMS will require additional mitigation, monitoring and/or reporting measures, based on the best available information at that time and in consultation with the FWS, to reduce the potential for bird collisions. These measures may include, but are not limited to, outfitting of turbines with deterrent devices and/or temporary turbine shutdowns during periods of anticipated impact for turbines where monitoring has demonstrated significant mortality.

- <u>Decommissioning</u>: Section 2.5.3 of the BA and Section 2.5.1 of the DEIS contains detail on the proposed methodology for decommissioning and removal of the wind turbines. 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.

  The applicant would be required to remove all project components once operations have ceased and must provide a financial instrument or other assurances to secure this obligation. Monopiles would be removed by cutting from the inside at approximately 15 feet below grade. Depending on the capacity of the available crane, the monopile may be cut once or may be cut into several pieces. Cutting of the piles would be done using a combination of underwater acetylene cutting torches, mechanical cutting, or high pressure water jet.

  The applicant is required to submit a decommissioning plan to MMS for approval which satisfactorily demonstrates the removal and recycling of equipment and associated materials thereby returning the area to pre-existing conditions. MMS will then approve or disprove the plan based on the best information on available at the time (i.e., advances in cutting technologies or the development of new technologies with less of an environmental footprint). MMS will consult with FWS prior to approval of this plan to ensure the plan's components are covered under any ESA biological opinion issued on this project and that any additional mitigation and monitoring measures are identified and implemented.

8.2.3 Existing Knowledge on Potentially Available Monitoring Technologies/Methods and the Effectiveness of these Technologies/Methods

MMS recognizes that there is little baseline information available to best understand the most effective and appropriate mechanisms for monitoring for impacts of the proposed project or offshore wind facilities in general on ESA-listed birds. Post-construction collision monitoring at existing facilities in the U.S. and in Europe have involved carcass searches at on-shore and near-shore sites (Vliestra, 2007; Arnett *et al*., 2005; Erickson *et al.,* 2004; Jain *et al.,* 2007; Everaert and Stienen, 2006), nighttime thermal imaging investigations of bird and bat turbine-interaction behavior at on-shore and off-shore facilities (Arnett *et al.,* 2005; Desholm, 2006; Huppop *et al*., 2006), day and nighttime radar surveys of bird migration to investigate avoidance behaviors (Huppop *et al*., 2006; Tulp, 1999; Kahlert *et al*., 2003; Christensen and Hounisen, 2005; Pettersson, 2005), and daytime visual surveys at on-shore, offshore, and near-shore facilities (Vliestra, 2007; Osborn *et al.,* 1998; Pettersson, 2005; Everaert and Stienen, 2006). Computer models have been created to predict changes in populations or increases in mortality associated with displacement from foraging areas for diving ducks (Kaiser, 2002). Other current studies are investigating the use of bat acoustical detectors, radio telemetry, infra-red cameras, and blade collision sensor systems at existing wind turbines. However, the effectiveness testing and results for the majority of these measures has, for the most part, not yet been completed or reported. Therefore, the effectiveness of many of these measures is still unknown.

The Massachusetts Audubon Society (MAS) has also recommended an *Adaptive Management Plan* be implemented consisting of a three-year monitoring plan integrating the use of visual aerial surveys coupled with ground-truthing surveys from the ESP, radar surveys conducted from the ESP, and surveys to monitor collisions using infrared cameras with digital recordings triggered by collision impacts. In addition to assessing collision mortality, the objectives of the surveys would be to research differences in avian behavior, abundance, and distribution between the baseline, construction, and post-construction periods. The details of this plan can be found in the CD accompanying this formal consultation initiation package. MMS has considered the contents of this plan in designing our approach to monitoring for project impacts on birds and has determined that the MAS plan, although not incorporated directly into this BA, will be an additional tool used and reviewed by the panel of experts that will ultimately refine the applicant's AMRP (see below).

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Report reference format, i.e., Report No. B-1, refers to a report referenced within this appendix only.

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APPENDICES

Appendix A

Response to Comments and Recalculations of Collision Risk for Roseate Terns

Response to Comments and Recalculations of Collision Risk for Roseate Terns

These responses were requested by Minerals Management Service for the Cape Wind Project in Nantucket Sound to facilitate revision of the Draft Biological Assessment. This document contains the following four responses:

- Response A Recalculations of Collision Risk for Roseate Terns
- Response B Response to Anonymous Review of the Draft Biological Assessment – Collision Estimates
- Response C Response to U.S. Fish and Wildlife Review of the Draft Biological Assessment
- Response D Response to Ian Nisbet Comment #9

RECALCULATIONS OF COLLISION RISK FOR ROSEATE TERNS – CAPE WIND PROJECT (RESPONSE A FOR MMS)

The following paragraphs address points raised by Ian Nisbet (2008) in his comments on the draft Biological Assessment (particularly concerning pages 19 – 22 of the comments) and in his appended "Rough Recalculation…", a 3-page memo that proposes revised values for six of the parameters used in the collision model for the Cape Wind project by Hatch and Brault (2007). Together, these proposed revisions yield a multiplicative factor of x 21.65 for the estimated collisions by Roseate Terns. The present document reviews the proposed revisions and offers an alternative further estimate of possible mortality of 2 Roseates per year. We suggest that MMS incorporate both the results from Hatch and Brault (2007) and the results reported here into the revised Biological Assessment. Additional fieldwork would be expected to reduce some of the identified uncertainty, but much would remain.

High-Flying Terns

The possibility that high-flying terns may be more numerous than the estimates used in the collision model could affect three parameters because all such unreported terns would be traveling: Parameter **A** (the numbers of terns in the project area), Parameter **D** (the fraction traveling) and Parameter **F** (the fraction of travelers at rotor height). The values for these parameters selected by Nisbet contribute greatly to his revised estimate of mortality. For instance, in proposing a revision of parameter F, Nisbet writes "…I suggest that it would be reasonable to assume that most or all terns flying with a following wind…are likely to fly at rotor height. This would yield a value of about 25%." This results in a multiplicative factor of 5.0. However, this comment is more likely to apply to "traveling" terns than to "all terns flying", many of which are foraging. Many terns traveling over water fly quite low, perhaps especially when their destination is nearby or to facilitate opportunistic shifts to foraging. Many years of field experience suggest that travelers are more likely to be at rotor height when flying downwind towards a known destination: not only a colony or roost but also a high-quality, distant feeding site in current use (as in the observations near Monomoy reported in Report No. BA-1).

However, as noted by Hatch and Brault (2007), these conditions do not generally apply to terns flying over Horseshoe Shoal. Terns traveling between Buzzards Bay (via Woods Hole) and the roost at South Beach would pass North of the project area and those flying between that roost and the Islands (Nantucket to Muskeget and nearby sandbars) would pass South of the project area, as would terns traveling between Buzzards Bay and the Islands. Horseshoe Shoal does not lie across direct routes between important daytime staging areas and the main roost-sites used at night. The records of the

Massachusetts Natural Heritage Program (March 2008) identify 12 staging areas, two of which are the main roosting areas mentioned above; terns traveling directly from four of the minor sites to the Islands would be likely to fly near or over the project area, but for each of these sites the roost at South Beach is closer. Terns flying directly from Katama, Martha's Vineyard, towards South Beach would be likely to cross the project area, but roost-sites on the islands are closer. No foraging areas have been identified that would be likely to create frequent streams of commuters across Horseshoe Shoal.

The concern about unrecorded high-flyers has two principal sources: the discrepancies between the data from the radar and from the boat and aircraft surveys, and perceived inadequacies of the visual surveying. The discrepancies between the radar and the visual survey data (#9 of Nisbet's comments appearing on pages 13-14 of Nisbet (2008), originally submitted in 2005) are addressed in a separate document (Response D). The visual observations are considered next.

Visual observations during the aircraft surveys of Nantucket Sound have apparently been inadequately explained and have been misinterpreted. The following comments are intended to extend descriptions in previous documents and address concerns (e.g., Nisbet 2008, page 20). However, it is necessary to recognize that the data for the proportion of terns at rotor height used in the model came from boat-based observations rather than the aircraft surveys. During an aerial transect an observer principally focuses attention on a narrow strip of water and records birds on the surface or flying close above it. While attending to that strip it is perceptually difficult to limit observations precisely to the wedge-shaped volume of air between it and the moving aircraft. This is particularly so when, as in the tern season, there are few birds present (unlike in winter when seaducks may be abundant). So, observers were able to be aware of a wider volume, approaching that of the rectangular cross-section alluded to in the earlier description (page 14 of Report No. 5.3.2-1). Such awareness may not amount to rigorous quantitative sampling of that volume but does provide useful indications. The rarity of high-flying terns is notable, especially because most of them would be conspicuous against the background of water. Throughout the surveys the pilot reported, over the plane's intercom, numerous observations of birds from his vantage point; although these observations were not systematic and did not form part of the datafile, they gave no indication that high-flying terns were being missed during the surveys.

The difficulties of detecting and identifying high-flying birds by eye, especially from a moving boat and against bright sky or cloud, are acknowledged, but the magnitude of the errors for terns at Horseshoe Shoal is unlikely to be as great as Nisbet proposes. His proposal is based on extensive field experience in the region, but not from Horseshoe Shoal. Some high-flying terns were recorded during surveys from moving boats; their conspicuousness and the absence, or rarity, of "almost-missed" individuals suggests that few others were overlooked. This conclusion is based on subjective impressions, but should not be ignored in the absence of counter-evidence. It seems unreasonable to suggest that if few terns were observed at moderate heights that large numbers occur at greatly higher altitudes, as would be required if many were missed by the observers. Uncertainty remains about the numbers and altitudes of travelers over Horseshoe Shoal, especially early and late in the day. Data from focused observations in August 2006 will be used to develop an alternative estimate. These observations, made near Monomoy, provide information about tern behavior at important times (early and late in the day) and season (post-breeding); application of these findings to Horseshoe Shoal must be done cautiously because it is about 25 km distant.

The observations reported in Report No, BA-1 from near Monomoy in August 2006 were made from a stationary boat in relatively sheltered locations so that detecting high-flying terns was expected to be more reliable. The two sites selected for the observations both related to the large and well-recognized pre-migratory roost and staging area at South Beach and the northern end of South Monomoy. The description used by Nisbet for these observations as "…far from any previously-reported staging area..." is inappropriate; the southern observation point was 6.5 km from the roosting area. At both observation sites, any terns seen could have been traveling to/from local feeding areas, but observers at the northern site potentially intercepted some of the movements to/from the western parts of the Sound, including Horseshoe Shoal and Woods Hole; at the southern site they would similarly have intercepted some of the terns flying to/from the Islands. The term "commute" is used to refer to repeated movements (or those involving many individuals over substantial periods of time) between two fixed locations and thus includes flights to/from known (often fixed) foraging sites: it is intended to distinguish such movements from opportunistic travels that may lead to foraging and is not confined to flights at specified times of day or season. These commuters showed a clear effect of wind direction and windspeed on flight altitude. For all commuters, the fraction at rotor height was 0.11; fewer than half of the downwind commuters were at rotor height. These included 110 individuals flying at altitudes >23m (the bottom of the rotor swept zone) but only one >100m, and 29 above the altitude at which the survey plane flew (75m).

While it is possible that the visual surveys at HSS missed statistically significant numbers of high-flying terns, and it would be valuable to know more about the determinants of flight-altitude, it is not reasonable to suppose that these numbers approached the 25% at rotor height proposed by Nisbet (in comments on parameter F). To address this possibility, we will use the data from August 2006 near Monomoy (0.11 of travelers at rotor height) to adjust the parameters A, D, and F and produce an alternative prediction of collisions (see below).

The following paragraphs address the parameters (A to H) of the model; Nisbet proposed amendments for six of these (as multiplicative correction factors). Revised factors are presented after addressing Nisbet's concerns and including the alternative height distribution with addition of hypothetical high-flying terns. When no amendment to the model is appropriate, and the values are unchanged, the revised factor = 1.0. The two sets of factors are summarized together below, following parameter H.

A: Tern numbers. The proposed correction factor (1.20) is based on the opinion that many high-flying terns were missed during the visual surveys at Horseshoe Shoal. The grounds for this belief are shown to be weak (see above). Including hypothetically unobserved high-flyers (see discussion above and F, below) would increase reported numbers of terns over Horseshoe Shoal by 6.7 percent. Revised factor: 1.07.

B: Proportion Roseate. Common and Roseate terns are difficult to distinguish visually (although their vocalizations are very different and Roseates are often notably more vocal than Commons near staging areas and roosts so that it is easy to overestimate the numbers of Roseates in a mixed flock). The values used in the model were 0.1 and 0.032. Nisbet rejects the low proportions recorded in the field reports from Mass Audubon and prefers the higher values from the Cape Wind surveys; he refers to unlikely projections from the low values of Roseates for the numbers of Commons present. Another approach to the topic is to suppose that Commons stage in similar ways to Roseates and that all those nesting in the northeast (from Newfoundland to Long Island, NY) gather around Cape Cod before migrating south (as has been suggested for Roseates). The breeding populations (pairs) of this area include 75,000 Commons (Nisbet 2002) that have recently been increasing, and 3,700 Roseates (Gochfeld et al. 1999) that have recently been decreasing, so that Roseates comprise <5% of the combined numbers. In the pre-migratory gatherings, the breeders are augmented by fledglings, but the species-ratio remains similar. Observations near Monomoy in August 2006 recorded Roseates to be 6.3 % of identified terns (Common + Roseate) (Report No. BA-1). (An aside: Arctic terns, abundant breeders in the Gulf of Maine and Canada, do not enter into this calculation because they do not stage around Cape Cod). This regional proportion of Roseates can be compared to the 0.25% they form nesting around Nantucket Sound. The numbers of terns seen at HSS were higher before and after the breeding season than during June and July when the adults are tending nests and chicks. The higher value used in the model (10%) is conservative and the proposed multiplicative factor is not appropriate. Revised factor = 1.0.

C = A x B.

D: Fraction traveling. This parameter is acknowledged to be uncertain and would be higher if the numbers of high-flying terns (all of them traveling) were increased. The birds recorded as traveling included those moving to a local feeding spot as well as those transiting the whole area. Many of the terns recorded as foraging are likely to be in that mode for much of the time that they spend over HSS, rather than switching completely from traveling to foraging at a particular spot. Furthermore, individuals foraging at one moment could be traveling at the next moment. The surveys, by recording “snapshots” of tern activity, capture the relevant proportion and additional time for unobserved travel is not appropriate. The inclusion of hypothetically-unobserved high-flyers, all of them traveling, would increase the fraction traveling to 0.56. Revised factor = 1.06.

E: Crossings of the project area. The proposed change in effective daylength (from 12.5 to 16.5 h) reflects a mistaken understanding of the rationale for the period used in the calculations. This period refers to the time potentially in the project area and not that of daily activity. As noted by Trull et al. (1999) and by Hatch and Brault (2007), some terns are known to arrive at the South Beach roost after sunset, but the (limited) evidence available suggests that arrivals peak before sunset and decline rapidly thereafter (see Report No. BA-1). It seems reasonable to suppose that most terns leave foraging areas when it becomes too dark to hunt effectively; similarly, earliest departures from the roost or colony in the morning may occur before sunrise (data are absent), but the deliveries of food to chicks at nests occur after sunrise, suggesting that commuting travels are constrained by low light-intensities at the foraging areas.

Boat-based observations at HSS on several days in May 2006 included 2 days when observations began near sunrise (not more than 10 minutes after) and the first terns were seen at 60 and 70 minutes, respectively, **after** sunrise; also 2 days when observations continued after sunset and the last terns were seen 100 and 42 minutes, respectively, **before** sunset (ESS, unpublished). These observations, although limited in extent, were from a stationary boat (at varying locations) and were made in conjunction with the GMI radar.

Travel between the project area and the roost at South Beach, or the colonies in Buzzards Bay, takes about 45 minutes. This suggests that the numbers of terns traveling **in the project area** after dark are very low (if not zero) and not sufficient to justify extending the effective day length to 16.5 h for the purpose of calculating number of crossings. The proposed correction factor is not appropriate. Revised factor = 1.0.

F: Fraction of travelers at rotor height. As noted above, the assumptions leading to Nisbet's multiplicative factor of 5.0 for this parameter generally do not apply to Horseshoe Shoal. However, there are marked concerns about high-flying terns that were possibly missed during the surveys from moving boats. The high value (0.31) obtained from stationary vessels during ground-truthing in May 2006 (and used in Hatch and Brault's Table 3) is likely unreliable because the radar operator was unable to pick up many of the low-flying terns. Focused observations in August 2006 yielded a value of 0.11 from sites near Monomoy (Report No. BA-1). This value will be used for the present estimate (and for parameters A and D). Revised multiplicative factor = 2.2.

G. Number of rotors encountered. The output of the geometrical Bolker model was generally accepted by Nisbet. Revised factor = 1.0

H: Probability of collision. The original text was particularly cautious about this important and little-understood parameter. It is incorrect to assert that "there is no evidence whatsoever from which it could be argued that avoidance at HSS would be either greater or smaller than at Zeebrugge" (Nisbet "Rough Recalculations" parameter H). It is correct that Roseate Terns are intermediate in flight characteristics between Common and Sandwich Terns, but this applies to flight under the same conditions. The values selected for Roseates at HSS were based on the expectations that they would not fly like Commons do near their nesting area at the Zeebrugge windfarm and that the results for Common Terns there were misleading. Thus, it is reasonable to suppose that Roseates at HSS would fly more like the Sandwich Terns reported by Everaert and Stienen (2007). The proposed multiplicative factor is not appropriate. Revised factor = 1.0.

SUMMARY AND CONCLUSIONS

The parameters of the collision model (Hatch and Brault 2007) (see H&B below) are listed below, with the multiplicative factors proposed by Nisbet (2008) (see N below) and the revised factors developed in the present document.

H & B parameter:	A	x B	x D	x E	x F	x G	x H	=	1.00
N's proposed factors	1.2	x 1.45	x 1.30	x 1.32	x 5.0	x 1.0	x 1.45	=	21.65
Revised factors:	1.07	x 1.0	x 1.06	x 1.00	x 2.2	x 1.0	x 1.0	=	2.48

(The final combined factor was calculated without rounding).

The estimate of mortality developed by Hatch and Brault (2007, section 12) was 0.83 terns/year; applying the revised factors evaluated above yields an alternative estimate of 2.06 collisions per year by Roseate Terns. Following the procedure of Nisbet 2008, and assuming that the proportional range of values for each parameter remain the same, the lower and higher 5% probabilities (analogous to 95% confidence limits) would be approximately 0.02 to 20 collisions. This alternative estimate includes the hypothetically greater numbers of high-flying terns addressed above. **This estimate is presented as an "alternative" rather than as a revision because the relevant data to enable a choice between them are not available.**

The method used in the preceding paragraph does not take into account the sensitivity of the estimate to the different parameters. However, this appears to be unimportant because calculating mortality from the expected values (as in Section 11 of Hatch and Brault) yields a similar result. These values, revised appropriately for the hypothetical high-flyers, with the higher of the 2 values for fraction of Roseates, and the lower of the 2 values for probability of collision yields an estimate of 2.06 deaths per year: the equivalent earlier estimate (one of four presented) was 0.81 (Hatch and Brault 2007, section 11).

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RESPONSE TO ANONYMOUS REVIEW OF THE DRAFT BIOLOGICAL ASSESSMENT FOR THE CAPE WIND PROJECT – COLLISION ESTIMATES (RESPONSE B FOR MMS)

The present responses will refer, when appropriate, to another document (Response A) that addresses topics raised by Nisbet (2008) that overlap Anonymous to a substantial extent. The present document is Response B.

Activity of terns at night. Anonymous correctly indicates that direct observational information about nocturnal movements of terns is limited; much depends on inferences drawn from movements observed near dawn and dusk. The timing of evening arrivals at, and morning departures from, nocturnal roosts (and nesting colonies) are addressed in Response A under Parameter E.

As noted by Anonymous, terns may leave the colony-site at night in response to predators such as Great Horned Owls. At Bird Island, when conditions have allowed (on unusually calm nights), tern biologists have heard flocks of such displaced terns as they flew over the nearby waters in darkness through the night. It seems reasonable to infer that such flocks remain near the colony, but information confirming the absence of long-distance movements could be useful.

Limits of visual observations. Although Cape Wind's aircraft surveys did not include an observer dedicated to looking for high-flying terns, the pilot reported numerous sightings over the plane's intercom of birds beyond the transects and at high altitudes: these did not suggest that significant numbers of high-flying terns were present.

Observing from small moving boats, for example running transects in bad weather, prompts legitimate concerns about the possibility of missing high-flying terns; see Response A for a new approach to this matter.

Habitat changes. Possible increases in the numbers of small fish on HSS resulting from construction of a windfarm are not expected to have adverse effects on risks of collision because any additional terns would be foraging and thus flying below the rotors during their presence in the project area. The "new" fish would be expected to occur in small numbers at each of the installed structures and would be unlikely to form a localized feeding "hotspot" to which terns would be likely to travel directly and thus possibly at rotor height.

The model assumes that effective measures to prevent terns resting on the wind-turbines and the service platform will be present continuously so that the terns will be unlikely to engage in risky behaviors such as courtship flights.

Turbines encountered. The probability of encountering turbines was obtained from the Bolker model, published online, for which a link to the website was provided (Hatch and Brault 2007, page 16). This method of presentation enables the reader to explore the performance of the model and potentially examine various scenarios, thus obtaining deeper insights.

Avoidance. Also see Response A. It is, indeed, reasonable to suppose that avoidance rates are lower when visibility is poor; the rate used in the collision model includes this variability. The rate is derived from studies at the windfarm in Zeebrugge, Belgium, which is adjacent to a tern colony (Everaert and Stienen 2007) and incorporates collisions in all the weather conditions encountered by terns there. This rate is likely to be conservative for HSS because nocturnal activity and risky flight behavior are higher close to a colony than distant from it. For the monopoles, avoidance is considered to be complete: the incident of a probable collision with the Bird Island Lighthouse, mentioned by Anonymous, is of very limited relevance to Horseshoe Shoal because the lighthouse is in the middle of a large tern colony where potentially risky behaviors occur frequently. At the Zeebrugge windfarm mentioned above, a disabled turbine was without blades for a year: no collisions of terns were reported from that tower J. Everaert, personal comm.; Hatch and Brault 2007, page 19).

Utility of additional fieldwork. Anonymous recommends that additional fieldwork be required to enable revision of the collision estimate. Three points to consider in relation to this recommendation are as follows. Adequately filling some of the identified datagaps may be impractical with available technology (for example, tern movements at HSS in storms or at night). Correctly identifying distant terns as Roseate or Common will continue to be difficult and a problem that is particularly liable to observer expectation error. Avoidance introduces such great uncertainty that reliable predictions of collisions cannot be expected (Chamberlain et al. 2006) before construction: this cannot be measured in the species- and location-specific manner desired and additional indirect methods like those employed in this model seem of limited value. While there is no doubt that some data gaps could be filled, the remaining uncertainties will be very large.

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RESPONSE TO U.S. FISH AND WILDLIFE REVIEW OF THE DRAFT BIOLOGICAL ASSESSMENT FOR THE CAPE WIND PROJECT (RESPONSE C FOR MMS)

Page 5-17—*the reader is left wondering if uncertainty is factored into the model.*

Response

There is little data available on potential roseate tern crossings of HSS during crepuscular periods, periods of fog or rain and during nighttime migration movements when the risk of collision is elevated. It is, indeed, reasonable to suppose that avoidance rates are lower when visibility is poor; the rate used in the collision model includes this variability. To account for this potential, the avoidance estimates used in the model reflect a diverse range of conditions based on observations and collision rates of terns at a wind farm in Zeebrugge (see sections 8, 9, and 10 in Hatch and Brault 2007 Report No. 5.3.2-1). The wind farm is adjacent to a tern colony; data on tern collisions in various weather conditions was collected by researchers during the breeding season of 2004 and 2005 (Everaert and Stienen 2007). In addition, observations of terns flying to and from the colony were made during two full days (including dawn and dusk), which were combined with collision data to develop a collision probability for terns at the wind farm (Everaert and Stienen 2007). Two nocturnal tern surveys were also conducted using night vision goggles but none was observed. The data collected by Everaert and Stienen (2007) provided the best available information to estimate tern avoidance rates under various conditions.

Page 5-20—*However, what about the very real possibility that terns also cross the sound after or before daylight hours… not accounting for that extra time would lead to an underestimate…Most of those behaviors only apply to terns crossing during the nesting period and NOT to terns present during the post-breeding staging period. It is this latter period when most tern crossings are made, calling into question whether there is an over estimate or not.*

Response

The likelihood that terns cross the Sound after dark is very low. As noted by Trull et al. (1999) and by Hatch and Brault (2007), some terns are known to arrive at the South Beach roost after sunset but the (limited) evidence available suggests that arrivals peak before sunset and decline rapidly thereafter (ESS 2006 Report BA-1). It seems reasonable to suppose that most terns leave foraging areas when it becomes too dark to hunt effectively; similarly, earliest departures from the roost or colony in the morning may occur before sunrise (data are absent) but the deliveries of food to chicks at nests occur after sunrise, suggesting that commuting travels are constrained by low light-intensities at the foraging areas. The collision model accounts for the time when terns are potentially in the project area (see response A, parameter E.)

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RESPONSE TO IAN NISBET COMMENT #9 – CAPE WIND PROJECT (RESPONSE D FOR MMS)

Page 13 and 14 of Ian Nisbet's Comments on the draft BA No. 9. Discrepancies between radar and aerial survey data.

The radar data were not interpreted and were not compared with the visual observations in any way, despite the reported intention to "ground-truth" the radar data and despite that Corps' specification that "Data gathered through radar should be validated with direct observations". For example, terns are probably the seabird species at greatest risk in September. During 24 days of daytime operation in September, a total of 174,113 "Slow" and 128,861 "Fast" targets were tracked by the TracScan radar. These were calculated to correspond to average traffic rates of 46.7 and 34.6 targets per km of front per hour respectively. Using the VerCat radar, 76% of daytime targets in September were above rotor height, 24% were in the rotorswept zone (23-126 m above sea level), and only 0.3% were below rotor height. There is a complete disconnect between the visual record of 356 individual birds within the study area on 25 September 2002, mostly cormorants, sea ducks, gulls and terns flying at altitudes less than 12 m above the water (Appendix 5.7-G, Table A), and the 11,156 targets detected by the radar on that day, mostly small and medium sized targets flying higher than 23 m (Appendix 5.7-J, Table 12). The Applicant's reports made no attempt to relate the two or to explain the discrepancy. Obviously, the radar data showing "targets" flying within the rotor-swept zone are directly relevant to risk assessment, but the Applicant's Evaluation dismissed the radar data in one sentence (Appendix 5.7-H, p. 22).

The Applicant's reports acknowledge that the radars were not configured to detect birds flying close to the water surface. But the failure of the aerial and boat surveys to detect the targets higher than 23 m requires explanation. The most likely explanation is that the observers in aircraft or boats simply missed the high-flying birds. Except for large dark birds such as cormorants, it is difficult to see high-flying birds against a bright sky, especially from a moving boat. The aerial surveys were conducted by looking downward between calibrated markers from an aircraft flying at 75 m altitude. In these circumstances, no birds flying higher than 75 m would have been observed, and birds flying between 23 and 75 m would have been difficult to detect (a) because the observers' attention was directed to the sea surface, (b) because the width of the transect declined linearly with distance below the aircraft, and (c) because they would be seen more fleetingly than birds further below. For these reasons, the data on heights of flight reported in the aerial and boat surveys should not be used to infer lack of risk.

Response

No attempt was made to link the aerial survey data from September 25, 2002, with the TracScan radar data from the same day because these datasets used very different methodologies for data collection (USACE DEIS-DEIR, Appendix 5.7-G, Table A and Appendix 5.7-J, Table 12). A summary of these differences is presented in Table 1 below. The discrepancy between the 356 birds observed by plane within the aerial flight study area and the 11,156 targets detected by radar on the same day is partially explained by two key facts. First, the radar collected data over a 10.4-hour period while the aerial survey was only conducted for a period of four hours and twenty minutes on that same day. Second, the area covered by the aerial survey differed from the area covered by the radar survey. The 356 birds observed by plane include those seen only over water within the Nantucket Sound study area which included all three alternative sites. The radar was positioned at Cape Poge, Martha's Vineyard, during the time of the survey. The four mile radius range of the TracScan radar only partially overlapped with the aerial survey study area and included areas over land. Because of the difference in the timing and location of the aerial and radar surveys, it is very difficult to make any correlation of bird counts between these two data sets.

Table 1. Differences in methods, time period, and survey area for numbers used by Nisbet[1].

Number	Survey Method	Time Period	Survey Area	Source
356 birds	Aerial – over water only	4 hours, 20 minutes during the day on 9/25/02	56.48 square miles throughout Nantucket Sound	DEIS-DEIR Appendix 5.7-G, Table A
11,156 targets	Radar – TracScan Passage rate only; land & water	10.4 hours during the day on 9/25/02	4 nm radius from location on Cape Poge	DEIS-DEIR Appendix 5.7-J, Table 12

Despite the differences in methodology, Cape Wind attempted to make a rough comparison between the number of targets recorded by the TracScan and the number of birds observed by plane on September 25, 2002. Based on the raw numbers that Nisbet cites, the TracScan target count is approximately 31 times higher than the aerial survey bird count. However, this rough comparison does not consider the difference in area and timing of the aerial and radar surveys. In order to make such a comparison, the number of birds observed by plane during the survey period on September 25, 2002, needs to be compared to the number of targets recorded by the TracScan for an equivalent sized survey area and length of time. That is, the radar counts targets for its entire survey area every 10 seconds, while the plane survey takes 4 hours and 20 minutes to count birds in its survey area. Accordingly, the 356 birds observed by plane was divided by the total survey area of 56.48 square nautical miles which yields 6.30 birds/square nautical mile for the 260 minute aerial survey on September 25, 2002. The TracScan radar scans an area of 50.27 square nautical miles with each complete revolution it makes every 2.5 seconds (FEIR, Appendix 3.6-G). However, TracScan only records targets that are detected for at least 10 seconds. Therefore, we assumed that the number of targets detected by TracScan every 10 seconds is equivalent to the number of birds observed by plane during the 260 minute survey period because this is the amount of time it takes each method to survey approximately the same sized survey area. Starting with the 11,156 targets observed by TracScan on September 25, 2002, dividing by the 50.27 square nautical mile survey area, and then dividing by the number of 10-second intervals (3,744) within the 10.4 hour TracScan survey period yields 0.06 targets/square nautical mile/10 second interval.

Thus, after correcting for area and time using this methodology, the number of birds observed by plane is actually 105 times higher (6.30 birds/square nautical mile/survey versus 0.06 targets/square nautical mile/10 second interval) than the number of targets detected by TracScan. With more information on radar performance and post-processing, it may be possible to devise a more suitable method for comparing the aerial survey bird counts with an equivalent "snapshot" of the TracScan radar data. However, our attempt to compare the two datasets using the methodology described above illustrates the difficulty in trying to correlate the aerial data and radar data.

Nisbet also claims there is a discrepancy in the altitude of the 356 birds observed by plane on September 25, 2002, which were flying at altitudes less than 12 meters, and the 11,156 targets observed by radar

[1] The TracScan and VerCat numbers used by Nisbet are from the original 2002 radar report in the DEIS. This report was re-analyzed and included in the FEIR. For the purpose of responding to Nisbet's comments, the original numbers are used. See Appendix 3.6-G of the FEIR for the revised numbers.

on the same day. Nisbet claims that these 11,156 targets were mostly “small and medium sized targets flying higher than 23 meters”. When the sources of these figures are reviewed, it becomes evident that these comparisons are not valid without making some questionable assumptions (Table 1). When discussing altitudes, it appears that Nisbet applies daytime data from the VerCat averaged across the **entire month** of September (USACE DEIS-DEIR Appendix 5.7-J, Table 8) to the TracScan data for the day on September 25, 2002, to draw a conclusion on the height of these targets (USACE DEIS-DEIR Appendix 5.7-J, Table 12). However, the information on the 11,156 targets collected by TracScan does not provide any direct data on the height of the targets; there is nothing known about their actual altitude. Altitude information is only available by assuming that the altitude of the targets collected by the VerCat during the entire month of September can be applied to the targets observed by the TracScan on a single day. This may not be valid considering the VerCat was positioned on land on Cape Poge and only scanned a small band width 1° wide, compared to the 4 nm radius scanned by TracScan. At least a portion of these targets was likely flying over land and birds have been observed flying higher over land than over water.

It is possible to make a limited comparison between the VerCat data and the data from the aerial surveys. However, comparisons should be made with great caution because of the differences in survey timing, survey area and the fact that the VerCat data from the fall of 2002 is biased towards recording higher targets. The MARS unit was positioned 28 ft (8.5 m) above MSL on Cape Poge and the center of the VerCat radar scanner unit sits 8 ft (2.4 m) above the ground level of the MARS unit (USACE DEIS-DEIR Appendix 5.7-J). In the fall when MARS was deployed at Cape Poge, VerCat data begins at 36 feet (28 ft + 8 ft) above mean sea level. Any bird flying below 36 feet was not detected by the radar.[2] In addition, wave clutter near the water surface can obscure low flying targets and lowers the detection rate of these targets. Only targets with predictable motion that are detected for at least 10 seconds are retained as tracks in the MARS database. This leads to radar bias towards recording targets such as migratory birds which remain airborne and visible to the radar. It also makes the radar less likely to pick up resident targets, such as foraging terns which may not always follow a predictable movement pattern. All these factors combine to bias the VerCat to pick up higher flying targets.

It has been acknowledged in the Cape Wind FEIR (Appendix 3.6-I) that height estimates obtained from aerial surveys are likely to be subject to some error. The results of Cape Wind’s aerial surveys which suggest that few terns were flying at rotor-height has also been challenged because the observers were alleged to be observing only within a cone below the aircraft and thus not sampling all heights adequately. This is a valid concern for quantitative conclusions when many birds are present at or near the water surface, however this was not the case for most occasions when terns were present in Nantucket Sound: during these surveys the transects included all birds for the complete width to the height of the plane. Terns are relatively conspicuous and were detected over a wide area: the presence of substantial numbers of high-flyers would have been evident. Although Cape Wind’s aircraft surveys did not include an observer dedicated to looking for high-flying terns, the pilot reported numerous sightings over the plane’s intercom of birds beyond the transects and at high altitudes: these did not suggest that significant numbers of high-flying terns were present. See Response A and Response B for more on height estimates during aerial surveys.

[2] In the reanalysis of the 2002 radar data (FEIR Appendix 3.6-G), data in the original database was exploited to resolve targets incidentally occurring below the VerCat “horizon”. This data exists due to the angular spread of the 1° radar beam as VerCat points at the horizon and intersects the water at a distance of 0.3 nautical miles. This may have allowed some birds flying beyond 0.3 nautical miles of the MARS unit and below 36-feet to be detected by the radar.

Boat based surveys conducted by Cape Wind and Massachusetts Audubon revealed similar results for altitudes of terns flying at rotor height (FEIR, Appendix 3.6-I). The heights of terns from boat based surveys rather than aerial surveys were used to develop a collision risk estimate. The general conclusions from the boat-based observations are that most traveling terns, as well as all foragers, were observed below the height of the proposed rotors. About five percent (4 to 6) of travelers were reported at rotor height. This number combines the median of 8 diverse samples and the mean of the numbers observed. The observations during the aerial surveys were consistent with these conclusions. See Response A and Response B for more on height estimates during boat surveys.

Though the aerial and boat surveys may be biased towards picking up lower flying targets, the VerCat is biased towards higher flying targets.

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Appendix B

Cape Wind Draft Avian Monitoring and Reporting Plan

Cape Wind Draft Avian Monitoring and Reporting Plan

NANTUCKET SOUND
MASSACHUSETTS

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Project No. E159-504.4

March 7, 2008

CAPE WIND DRAFT AVIAN MONITORING AND REPORTING PLAN
Nantucket Sound, Massachusetts

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FIGURES

1.0 INTRODUCTION

ESS Group, Inc. (ESS), on behalf of Cape Wind Associates (Cape Wind), presents this Avian Monitoring and Reporting Plan, prepared for the Minerals Management Service (MMS) as part of Endangered Species Act consultation with the US Fish and Wildlife Service (USFWS). This Avian Monitoring Plan was developed in coordination with MMS, and includes the following components.

- Summary of existing research and analysis
- A plan to test and monitor the effectiveness of anti-perching devices
- Protocols for aerial surveys to determine overall bird abundances and distribution in project area
- Protocols for boat surveys to investigate Roseate Tern use of the project area
- Protocols for monitoring avoidance and attraction behavior of Roseate Terns from the Electric Service Platform and select wind turbines
- Framework to conduct beached bird surveys
- Review of relevant studies from other offshore wind farms as they become available

The Avian Monitoring Plan outlines methodology and protocols to gather data that will be used to evaluate any impacts to avian populations in Nantucket Sound. In addition, data collected will add to the body of existing research on the affects of offshore wind farms on birds.

2.0 AVIAN MONITORING PLAN

2.1 Summary of Existing Research and Analysis

Cape Wind conducted and reviewed a number of studies starting in 2002 that characterized bird use of Nantucket Sound. Cape Wind's initial avian studies and reports were used to support the assessment of potential impacts to avian species and are summarized in the US Army Corps of Engineers (USACE) DEIS/DEIR (DEIR) of November 2004 (USACE, 2004). Since the release of the DEIR in 2004, Cape Wind has collected and reviewed additional data on bird use of Nantucket Sound which were presented in the Final Environmental Impact Report (FEIR) of February 2007 (ESS, 2007). The results of the DEIR and FEIR studies provide a robust data set on the existing conditions in Nantucket Sound and can be used to assess potential impacts to avian species. Additional studies included in the FEIR focused on Roseate Terns, the only Endangered Species Act -listed avian species documented to regularly use the proposed project site on Horseshoe Shoal.

Beginning in 2002, the Massachusetts Audubon Society (Mass Audubon) also conducted avian surveys and compiled data on bird use of Nantucket Sound from summer 2002 through winter 2006. Cape Wind has reviewed over four years of Mass Audubon data in support of its avian impact assessment.

A review of the Cape Wind and Mass Audubon studies provide general findings on the distribution of various avian groups within Nantucket Sound. For example, average tern density (number per square kilometer [#/km^2]) during breeding and staging periods was greatest in areas east of Horseshoe

Shoal, closer to Monomoy Island. Sea ducks were found in larger concentrations with the highest average densities in the area south of Horseshoe Shoal between Martha's Vineyard and Nantucket, followed by Horseshoe Shoal and Monomoy Island. Winter waterbirds were evenly distributed throughout the study area with the exception of several scattered areas of higher average densities outside of Horseshoe Shoal (ESS, 2007).

A primary area of research focused on tern use of Horseshoe Shoal. Multiple years of research have demonstrated that local tern distribution appears to vary annually and most of the birds observed on Horseshoe Shoal were observed traveling and not actively feeding or resting (Perkins et al., 2004a; Perkins et al., 2004b; Sadoti et al., 2005a; Sadoti et al., 2005b). Results of Mass Audubon boat and aerial surveys led researchers to hypothesize that Horseshoe Shoal is more important as a migratory stopover point or "refueling" area for terns than as a feeding area for locally nesting resident terns (Sadoti et al., 2005a).

Avian surveys on Horseshoe Shoal also provided information on the interannual variability of the local distribution of terns, and seasonal variability of tern distribution in the Sound (Sadoti et al., 2005b). These data provide the baseline characterization of tern use of Horseshoe Shoal, which will be compared with results from operational monitoring.

In addition, an analysis of the potential collision risk to birds was conducted by Hatch and Brault (2007). The best available data suggest that fatal bird collisions resulting from the operation of the Cape Wind Project will be in the range of 0 to 2 birds per turbine per year or a maximum of 260 total bird fatalities annually. Additionally, the potential distribution of species within this range of collision risk indicates that Roseate Terns are expected to have a mortality of 0.8 individuals/year and Piping Plovers are likely to sustain losses of less than one bird per year from the wind project (ESS, 2007). This Avian Monitoring Plan incorporates protocols that will provide data that may be used to compare to these collision risk estimates.

2.2 Anti-Perching/Roosting Evaluation

A method to prevent perching/roosting on all structures within the wind farm was originally outlined in the DEIR (USACE, 2004) and is also discussed in the MMS DEIS (Section 5.3.2.4.2). Anti-perching/roosting devices will be used on the wind turbine generators (WTGs) and electric service platform (ESP).

2.2.1 Description of Structures

Each WTG has a transition piece on top of the pile that has an access ladder and boat fender system connected to a deck (Figure 1). The deck is round through 180 degrees and has an extended section on one side. The diameter of the transition piece is 5.39 meters with a deck that is 8 meters in diameter with the extension section of 7.4 meters from the centerline of the transition piece. The deck will have a railing on the outer perimeter covered with an aluminum chain link fence. The deck overhangs the ladder.

The ESP has an overall size of 60 meters by 30 meters consisting of a building like superstructure sitting on a 6 pile structural support (Figure 2). The superstructure overhangs the support. The bottom of the superstructure is 11.5 meters from mean low low water and the top of the heliport deck is 30 meters.

2.2.2 Perching Concerns

There are several potential bird uses of the WTGs and ESP. Birds may use various perches around the edges of the platform as vantage points from which to watch for prey. Numerous species of birds are likely to use any suitable flat surfaces of the upper decks as places to rest by day and perhaps also by night (roosting). Terns could initiate high courtship flights from WTGs or the ESP and drift downwind to a nearby turbine (distance 1,640 feet [500 meters] or more) where they would be at risk of collision.

2.2.3 Perching Deterrents

As described in section 5.3.2.4.2 of the MMS DEIS, each WTG and the ESP will be equipped with an avian deterrent system to discourage terns and other avian species from perching on the railings and deck areas (Figure 3). The deterrent system consists of a fence to prevent access from the side, a stainless wire on top of the railing and a 0.65-meter tall panel to restrict visibility of any avian species from the deck.

The wire will be 3-millimeter stainless steel marine wire with swage lock terminals and turnbuckles to connect it to posts at appropriate locations to maintain it taut. The spacing between the rail and the wire will be 3 centimeters. The size selected will allow visibility of the wire to various species while being too small to perch upon. Birds, including terns, attempting to perch on the rails would not be at risk of colliding with or being entangled in the wire because it is very close to the rail. Birds attempting to land on the rail would undoubtedly decelerate to a point where their airspeed would be nearly zero, thereby negating the potential for collision injuries. The wire has been shown to be effective on the Cape Wind SMDS.

The anti-perching wire will be tested prior to construction at or near Waquoit Bay National Estuarine Research Reserve or other available areas with high tern densities. A test platform with an anti-perching wire will be placed in an area with heavy tern use. The number of terns using the platform with the wire will be compared to the number of terns using a second platform that does not contain the wire.

In addition, a 0.65-meter tall panel will be installed along the outside of the WTG railings. Panels will also be set up at the edges of the helipad, which is situated above the ESP (Figure 3). The panel will restrict visibility making the potential perching area unsuitable for web-footed birds that prefer to perch on near-flat surfaces with views of their surroundings. It is likely that birds may initially be attracted to the WTGs for perching, but effective deterrents will likely limit the number of times birds do this. Once they learn that they cannot perch, they will be unlikely to attempt to perch on turbines further. In addition to the passive deterrent, the WTGs and ESP will be operating most of the time resulting in vibrations and low level noise that may also discourage use by avian species.

The anti-perching devices on the WTGs and ESP will be monitored twice a month for two years in May, June, and July when tern abundance on Horseshoe is greatest based on past research. The ESP and WTG deterrent systems will be monitored for four hours during each monitoring event. A number of WTGs will be monitored from the ESP using a spotting scope. In addition, a camera will be installed so that the helipad can be remotely viewed from the Cape Wind Control Station. The Helipad will be observed first thing every morning and for five minutes at the top of each hour when the Control Station is manned. Results of monitoring the ESP and WTG deterrent systems will be reported to MMS in the annual monitoring report.

If perching remains an issue based on the monitoring, Cape Wind will screen and evaluate a number of additional anti-perching/roosting devices and mechanisms for potential use on both the WTG and the ESP. For each device or mechanism that advances through the screening process, Cape Wind will provide a visual detailing of the proposal and a narrative describing its expected action. To enable efficient testing, these devices may be tested in an appropriate environment where terns are more consistently present.

Additional devices and mechanisms to be evaluated on the ESP may include those listed below. Results of the evaluation will be reported to MMS in the annual monitoring report.

- Wire types
- Changing wire elevation
- Nets
- Spikes
- Coils
- Visual devices
- Water sprays
- Decoys
- Audio devices, including compressed air cannons

2.3 Abundance and Spatial Distribution Surveys

Cape Wind will conduct aerial surveys using the same methodology employed during the studies conducted for the DEIR and FEIR to document avian species abundance, and spatial distribution within the project area and Nantucket Sound. The flight plan for winter sea ducks and waterbirds is shown on Figure 4. Flight paths during the tern breeding and staging period will shift to include a transect near Monomoy Island (Figure 5). Cape Wind will fly five aerial surveys from May to late July (tern breeding period), four aerial surveys during the tern fall staging period from mid-August to late September, and ten surveys during the winter (mid October to mid-April) to monitor sea ducks and waterbirds. The surveys will be conducted for two years.

Cape Wind will fly surveys at an altitude of 76 meters (250 feet), which was chosen as the lowest possible altitude in order to observe individuals clearly down to sea level with minimal disturbance to bird behavior. The surveys will be flown in a floatplane (or equivalent) which will maintain an air speed of approximately 90 knots, or the slowest speed the aircraft can safely fly. The 76-meter altitude corresponds approximately to the rotor hub height (78.5 meters) of the proposed wind turbines. The flight lines will be slightly adjusted from pre-construction flight paths so that they are in between turbine strings.

Birds will be counted and identified along 16 transects spaced approximately 2,286 meters apart. Surveys will be flown at different times of the day, at different tides, and in somewhat varying weather conditions, but only when visibility is either good or excellent to ensure that birds can be seen. No observations will be made when sea states are greater than three to ensure birds on the water can be seen. Flights will not take place during inclement weather when the safety of the pilot and survey crew would be compromised.

The survey team will consist of the pilot, a data recorder, and two observers. The pilot will maintain the plane on transect, at the correct altitude and speed, and at the proper wing level attitude. Two observers will be seated on either side of the plane. An aluminum rod will be attached perpendicular to the wing strut on each side of the plane to delineate the transect boundaries. A clinometer will be used to measure the calculated angle for the placement of these aluminum rods. The distances between the plane's float and the aluminum rods will be initially verified by flying over the airport at 76 meters (250 feet) using pre-measured 200-meter (656 feet) markers on the ground. The area visible between the float on the plane and the aluminum rod will provide each observer with a 200-meter (656 feet) transect width within which all birds shall be counted. The observers will not be able to see the area directly below the airplane.

The data recorder and observers will maintain direct communication using aviation headsets. The observers will identify species, number of species, activity of bird (i.e., foraging or flying), and time of sighting. The data recorder will be responsible for entering the data identified by the observers and record a Global Positioning System (GPS) point of the location at the beginning and end of each transect in addition to a GPS point every minute during each transect. Each observer's sightings shall be independently recorded on an audiotape linked directly to each headset.

Results of the surveys will be transferred to a geographic information systems map to show abundance and spatial distribution of key bird species during specific times of year (tern breeding season, tern fall staging, winter seaducks, and winter waterbirds). Sea duck species include Common Eider, Long-tailed Duck, Surf Scoter, Black Scoter, and White-winged Scoter. Winter waterbird species include loon, grebe, Northern Gannet, American Black Duck, American Goldeneye, mergansers, Alcids, Dovekie, and Razorbill. The results of the post construction monitoring will be compared with pre-construction aerial surveys.

2.4 Tern Surveys

2.4.1 Monitoring Changes in Tern Activity

Boat surveys will be used to determine whether there is any change in Roseate and Common Tern use, abundance, distribution, behavior (e.g. traveling, feeding, and resting), and flight height at the wind farm. Twelve boat surveys will be conducted during the breeding period from May 1 to July 31. During the staging period, six surveys will be completed between August 11 and September 23. The surveys will be conducted for two years.

Boat surveys will follow the protocol and route established by Mass Audubon in 2002 through 2004. The surveys will be conducted along a series of transects oriented in two approximately parallel tracks, one mile apart. The positions and dimensions of these transects will be selected to sample the water over Horseshoe Shoal as well as the waters near the Shoal. Horseshoe Shoal has been defined as the roughly continuous area described by the 20-foot bathymetry line within the Cape Wind project area. The boat surveys will begin and end at waypoints in the northeast portion of Horseshoe Shoal, and follow a roughly crescent-shaped route out to and back from waypoints near the southeastern portion of the Shoal, just west of Halfmoon Shoal (Figure 6). Surveys will be conducted from a powerboat, cruising at an average speed of roughly 10 knots. Surveys will last approximately 2.2 hours. The linear length of the transect will be approximately be 24.9 miles.

The boat survey teams shall consist of two observers equipped with range-finders/clinometers and one recorder. The data collected will include numbers of birds seen by species, behavior (feeding, sitting, or traveling), flight altitudes, survey starting and ending times, weather (e.g., rain, sunny, cloudy), wind speed and direction, water temperature, sea state, and visibility. The observers, shall be positioned on each side of the boat immediately aft of the wheelhouse and verbally communicate all bird sightings to the recorder. Data will be recorded on a laptop computer using dLog, a computer program which records the geographical location of each observation. All birds observed within 0.5 mile on either side of the vessel shall be recorded. This distance will be periodically checked with the range finding function of the onboard radar in reference to visible objects such as buoys. Flight heights of the birds will be determined using a combination range finder/clinometer. Binoculars will be used to confirm identification of species as needed.

Flight behaviors, shapes, and plumage characteristics will be used to distinguish Common and Roseate Terns. All birds will be recorded to species whenever possible. In cases where it is not possible to differentiate between Roseate and Common Terns, the observation shall be recorded in a separate category of an undifferentiated tern species.

The results of the post construction surveys will be compared to the pre-construction surveys to determine if any changes are detectable. We will specifically focus on changes in tern abundance, distribution, and flight height. Results of the studies will be incorporated into the annual monitoring report.

2.4.2 Monitoring Avoidance and Attraction Behavior of Terns

In addition to monitoring for tern presence in the project area, field biologists will also monitor for avoidance or attraction behaviors at the ESP and select WTGs. Avoidance or attraction behaviors of terns will be made from a vantage point on the ESP. Cape Wind will deploy field biologists during the breeding season from mid-May to late July and the staging season from mid-August to late September to observe tern behavior around the ESP and adjacent WTGs. Observers will collect 32 hours of observations (staggered during day light hours) in field journals and photo document birds where possible. Observers will monitor tern behavior for avoidance or attraction to the WTGs or ESP.

2.5 Beached Bird Surveys

If deemed effective, beached bird surveys will be conducted to determine if the number of dead birds washing up on a representative stretch of beach changes significantly following the start of operation of Cape Wind's WTG's. Before implementing beached bird surveys, Cape Wind will first research wind and current data to determine likely locations for birds that may have collided with wind turbines to wash-up.

As described in the DEIS, Section 4.1.3.1.1 currents in Nantucket Sound are driven by strong, reversing, semidiurnal tidal flows. Wind-driven currents are only moderate because of the sheltering effect of Nantucket and Martha's Vineyard. The tidal range and diurnal timing are variable because of the semi-enclosed nature of the sound and the regional variations in bathymetry (MMS, 2008).

Tidal flow and circulation within the sound generate complex currents, the directions of which form an ellipse during the two tidal cycles each day. The complex bathymetry of Nantucket Sound forces the tidal ellipses to take different shapes in different regions of the sound. Just off the coast of the south shore of Cape Cod, there is a strong rectilinear, semi-diurnal tidal flow approximately parallel to the coast. The tidal current flows to the east during the flood tide (incoming) and to the west during the ebb tide (outgoing). Peak tidal currents often exceed two knots. The intensity of tidal flow, in general, decreases from west to east. There is a slow net drift of the water mass toward the east in the sound. The net drift is about 2,153 square feet (200 square meters) per tidal cycle, roughly five percent of the total easterly and westerly tidal flows (MMS, 2008).

To characterize site-specific tidal and wind-driven currents at the wind farm site in Nantucket Sound, analytical models were applied, with the results summarized as follows.

- Flood currents on the shoals are generally directed easterly, with ebb currents generally directed westerly
- Local changes in tidal current direction occur on Horseshoe Shoal due to its bathymetric features, with currents diverted slightly around the shallowest portion of the shoal
- Flood currents are generally stronger than ebb currents, and spring tidal currents are approximately 15 to 20% stronger than mean tidal currents

- Tidal current velocities were calculated to be approximately two feet/second (0.61 m/second) at Horseshoe Shoal

- Wind-driven current velocities modeled at Horseshoe Shoal were found to be much lower than tidal velocities, and were found to be concentrated over the crest of the shoal (MMS, 2008)

Based on the above information, it is likely that flow and ebb tidal currents would push carcasses east away from land. Cape Wind will conduct a survey to study the likely track of a bird carcass from the wind park and determine whether beached bird surveys are warranted.

Cape Wind will conduct beached bird surveys if wind and current data indicate that a carcass would likely wash up on a beach. Cape Wind will begin by coordinating with the Seabird Ecological Assessment Network (SEANET), an existing beached bird survey program (SEANET, 2001). Cape Wind will consult SEANET to collect existing survey data, determine locations of surveyed beaches in Nantucket Sound and discuss survey protocols. Any baseline information on beached birds along Nantucket Sound shorelines will be extremely valuable for comparison with beached bird surveys that will be conducted during wind farm construction and operation.

The basic methodology for the beached bird surveys is adapted from SEANET protocols and will be implemented at select Nantucket Sound beaches. There are currently surveys being done along the southern beaches of Cape Cod and eastern shores of Martha's Vineyard. There are no surveys currently being conducted along Nantucket shores.

Field biologists will be deployed on a monthly basis (one day per month for 36 months) to check for carcasses on beaches selected through the wind/current analysis. Surveys will be conducted at low tide, or just after high tide after any new carcasses have been deposited. Field biologists will survey the beach with a focus on the wrack line, where most carcasses are usually found. Secondary focus will be on the extreme high tide line and upper beach where older carcasses are sometimes found. When a bird carcass is discovered, the following information will be recorded: species information, examiner information, GPS location, weather conditions, specimen condition, wing chord, culmen (bill length), tarsus (leg measurement), degree of emaciation, and likely cause of mortality (if possible). Carcasses will be photographed and left in the location they were found if old. Carcasses will be marked by clipping a toe. Fresh carcasses will be brought to the Lloyd Center for the Environmental Studies for necropsy. The beached bird surveys will be conducted for one year each: preconstruction, construction period, and finally operation.

2.6 Review of Industry Studies

Cape Wind will continue to review available industry studies to evaluate collision monitoring programs at other offshore wind farms. Several sources provide the latest data and findings from existing offshore wind farms that Cape Wind may use to guide its own monitoring practices. The Collaborative Offshore Wind Research into the Environment (COWRIE) has conducted many studies at offshore wind farms in the United Kingdom (COWRIE, 2008). These studies were designed to address data gaps in knowledge on potential environmental impacts of wind farms. Reports produced by COWRIE will be reviewed and considered as they become available.

The National Wind Coordinating Committee (NWCC) was a collaborative formed in 1994 which identifies and addresses issues which affect wind power development. The NWCC Wildlife Workgroup defines, discusses and addresses wind-avian interactions and prepared the first comprehensive guide on metrics and methods for monitoring potential impacts on birds at existing and proposed wind energy sites (NWCC, 2007). Reports produced by NWCC will be reviewed and considered as they become available.

The National Renewable Energy Laboratory (NREL) is another source of information on the newest developments in the wind industry. The NREL has conducted studies on bird movement and behavior in relation to potential wind energy developments in the past (Morrison, 2006). NREL has primarily focused on land based wind farms, but is beginning to expand its research into offshore wind. We will continue to monitor information coming out of NREL.

Over 100 reports have been published studying environmental impacts at the 72 turbine Nysted offshore wind farm in Denmark. The most recent bird studies which examined collision risk at the wind farm were prepared in 2005. The most recent study on collision risk at Horns-Rev, an 80 turbine offshore wind farm in Denmark, was produced in 2005. Additional studies at Horns-Rev have examined numbers and distribution of birds in the project area and disturbance to birds as a result of displacement from habitat. We will continue to follow post construction monitoring at Nysted and Horns Rev since they offer pertinent information on the effectiveness of avian monitoring. New avian studies at other offshore wind farms will be reviewed as they are produced.

3.0 REPORTING

Cape Wind will submit a monitoring report at the end of construction and then annually by December 15 through the life of the project that contains the following information.

- A summary of results from the previous year's studies, including information that specifically addresses the research objectives outlined in the approved AMP
- Details of research plans and objectives for the coming year and how these will logically advance the research objectives outlined in the approved AMP

In addition, all federally and state listed avian collisions (with vessels, aircraft, turbines or structures) will be documented and reported within 24 hours to MMS [ENTER SPECIFIC CONTACT INFO] and USFWS [ENTER SPECIFIC CONTACT INFO], Fatalities of non-listed species would be reported annually to the USFWS, as is stipulated by standard USFWS salvage permits. Minimum data collection includes standard data collected during bird and bat fatality studies at wind plants including: name of person who found carcass or witnessed incident, species, date/time, location, weather, identification of the vessel, aircraft, turbine (turbine number), or structure involved and its operational status when the strike occurred, and known or suspected cause of death (if possible) and status of carcass (complete, incomplete, scavenged, time since death [approximate], etc.). Bird/carcass photographs should also be provided when necessary to document species identification or other relevant attributes. Carcasses of non-listed species shall be retained (for examination and documentation) in a freezer in zip-lock or similar bags with the above listed information included on non-degradable paper. For any banded or marked birds, record the presence and nature of the band (number on band should be recorded) or marking and include in reports. In addition for Federal or research bands and marking, information (band or other identification number) must be reported to the U.S. Geological Survey Bird Banding Laboratory (see http://www.pwrc.usgs.gov/BBL/homepage/call800.htm).

4.0 REFERENCES

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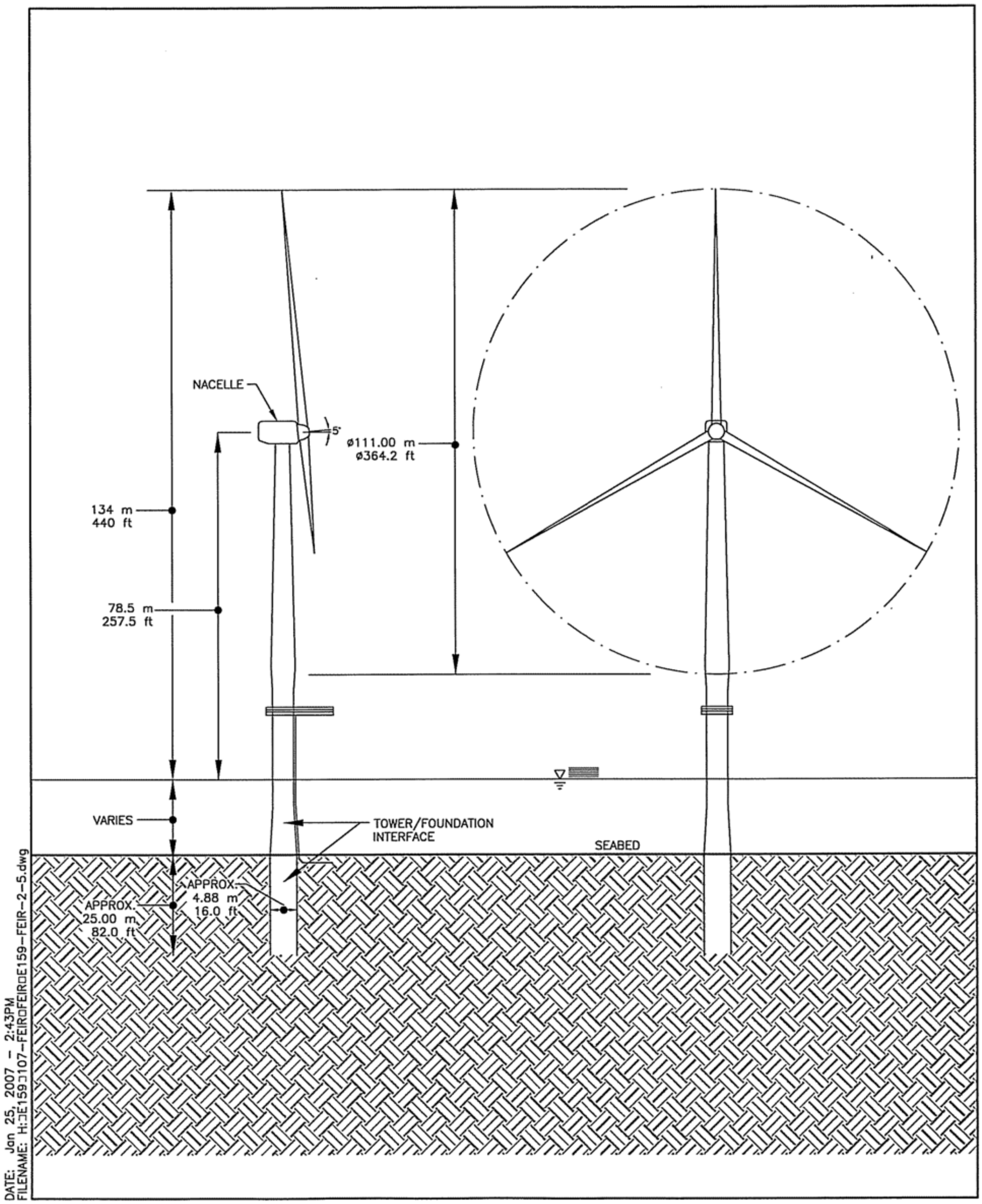
Figures

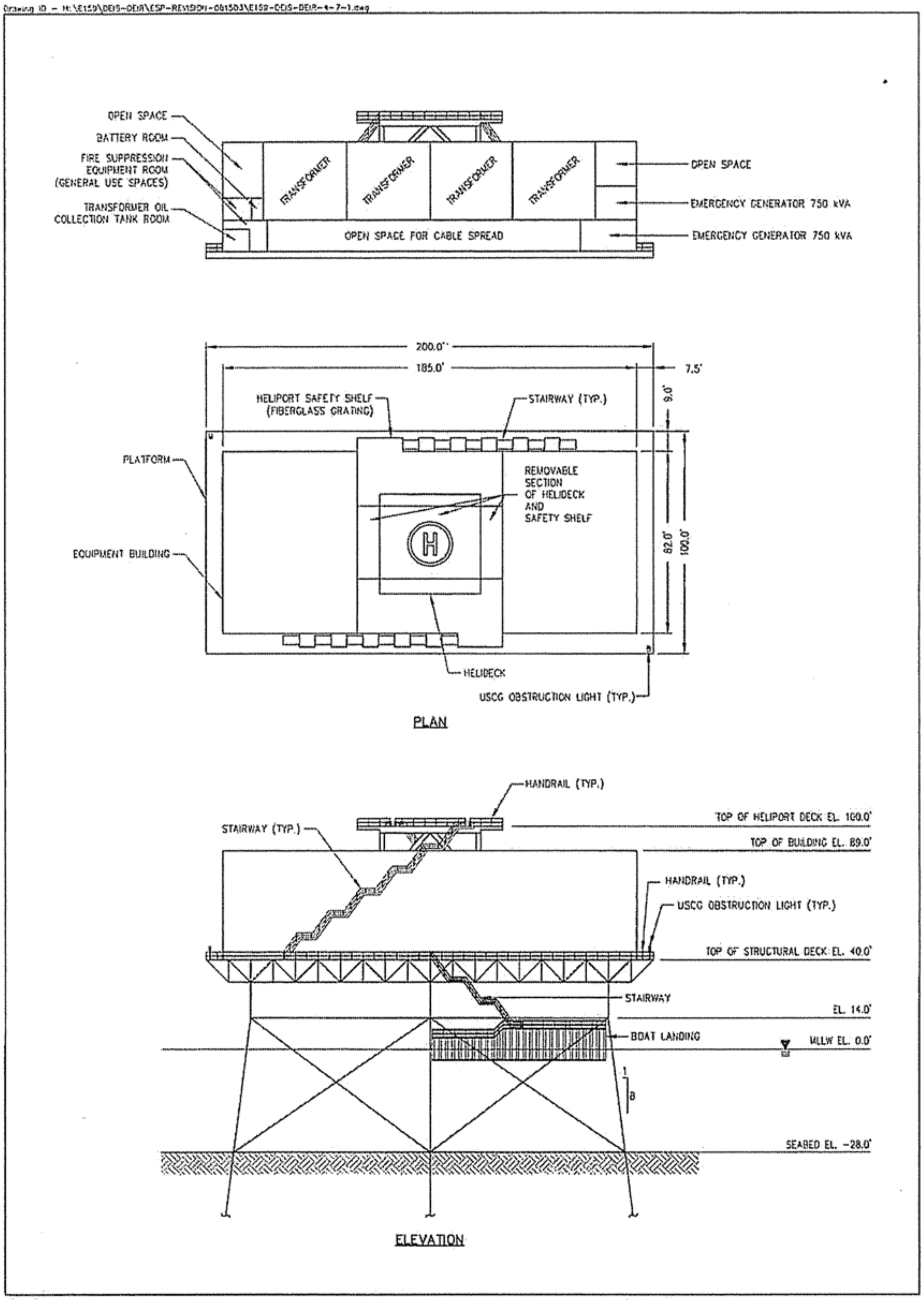


CAPE WIND AVIAN MONITORING PLAN
Nantucket Sound, Massachusetts

Source: ESS Group, FEIR, 2007

Typical Wind Turbine Generator (WTG)

Figure 1



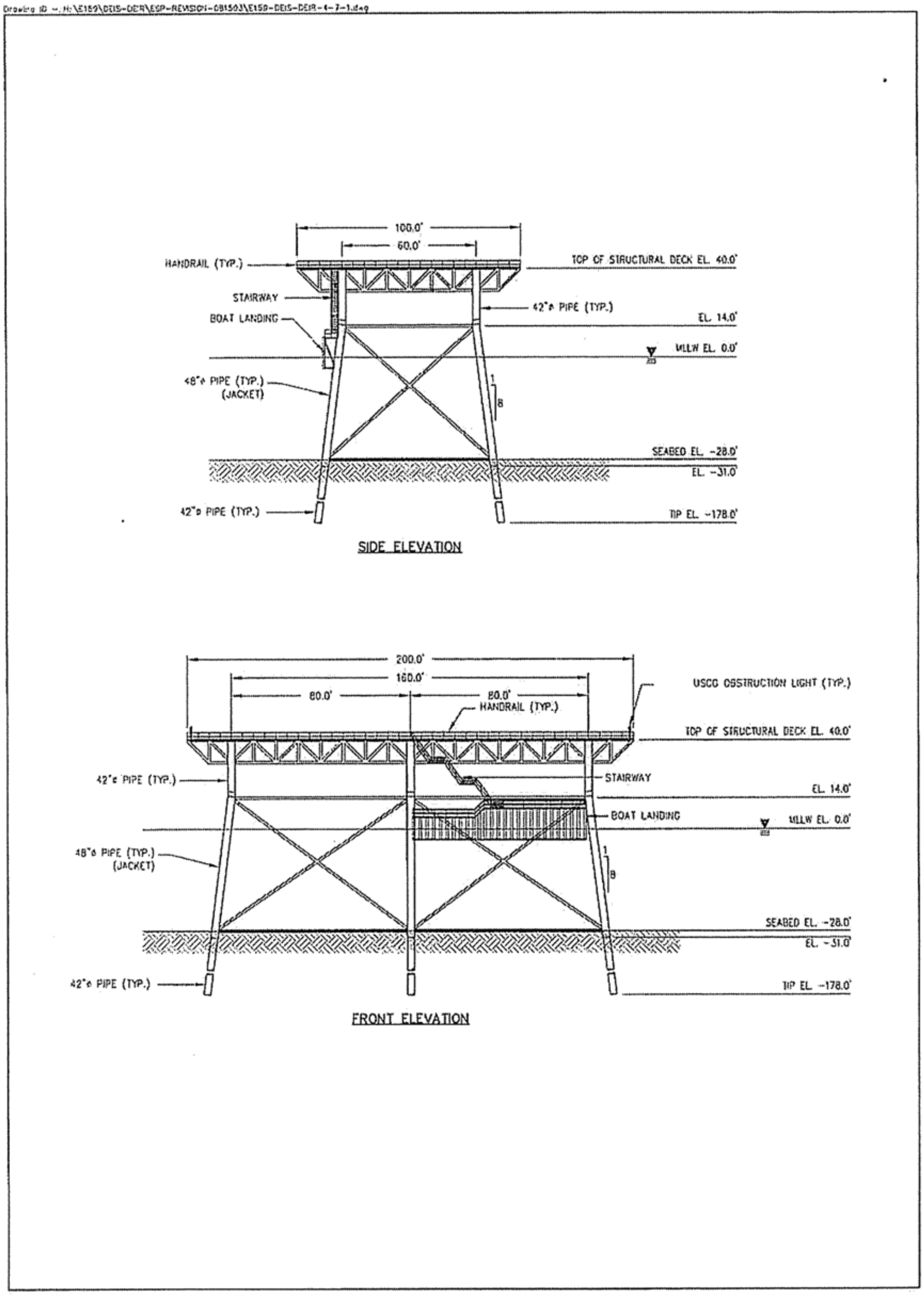
CAPE WIND AVIAN MONITORING PLAN
Nantucket Sound, Massachusetts

Source: USACE, DEIS, 2004

Electric Service Platform (ESP)
Sheet 1 of 2

Figure 2

ESS Group, Inc.
Engineers
Scientists
Consultants



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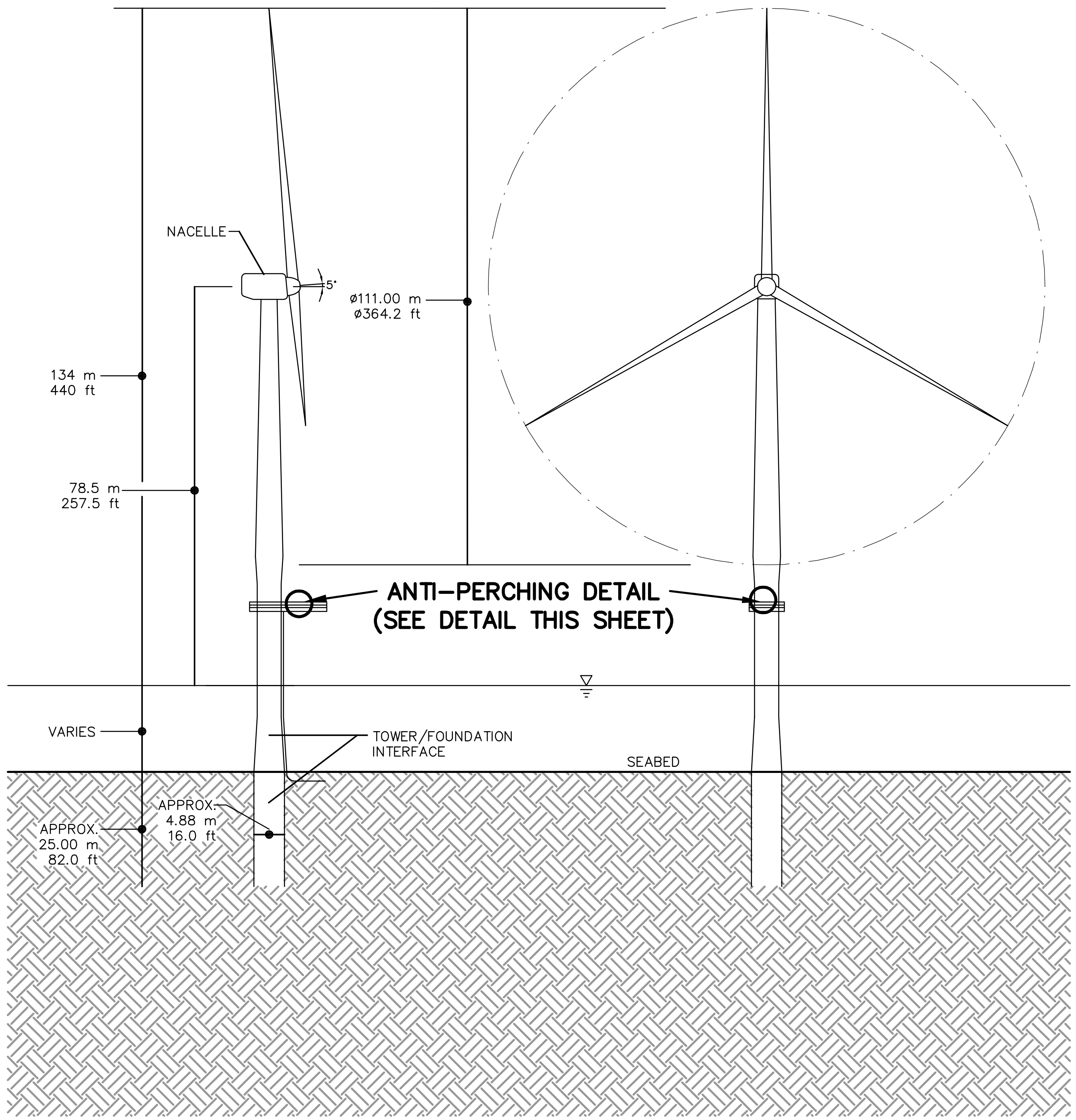
CAPE WIND AVIAN MONITORING PLAN
Nantucket Sound, Massachusetts

Source: USACE, DEIS, 2004

Electric Service Platform (ESP)
Sheet 2 of 2

Figure 2



PROPOSED WIND TURBINE GENERATOR
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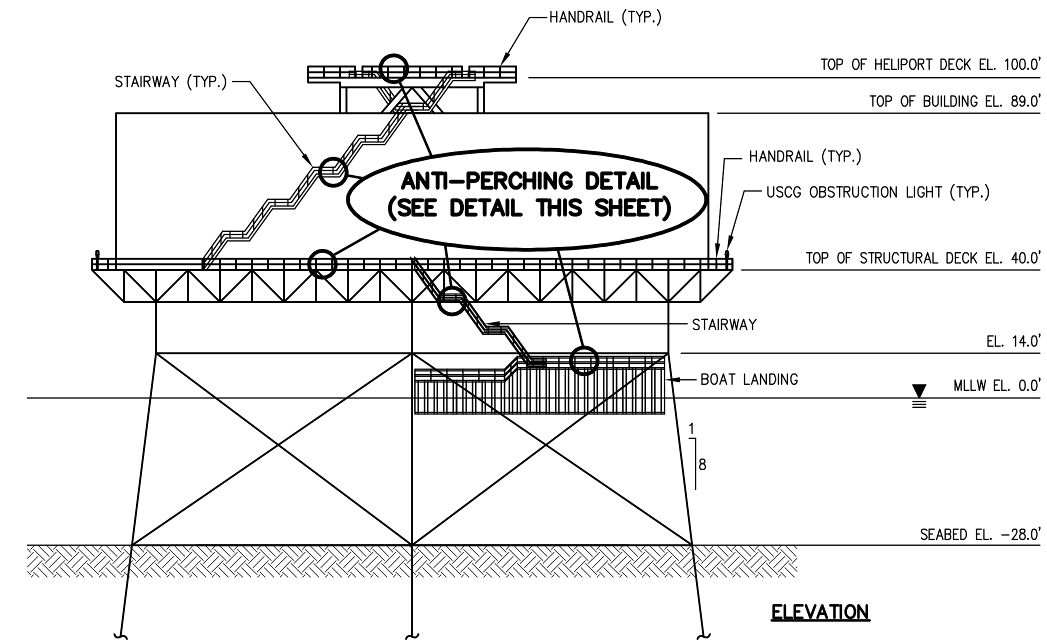

PROPOSED ELECTRIC SERVICE PLATFORM
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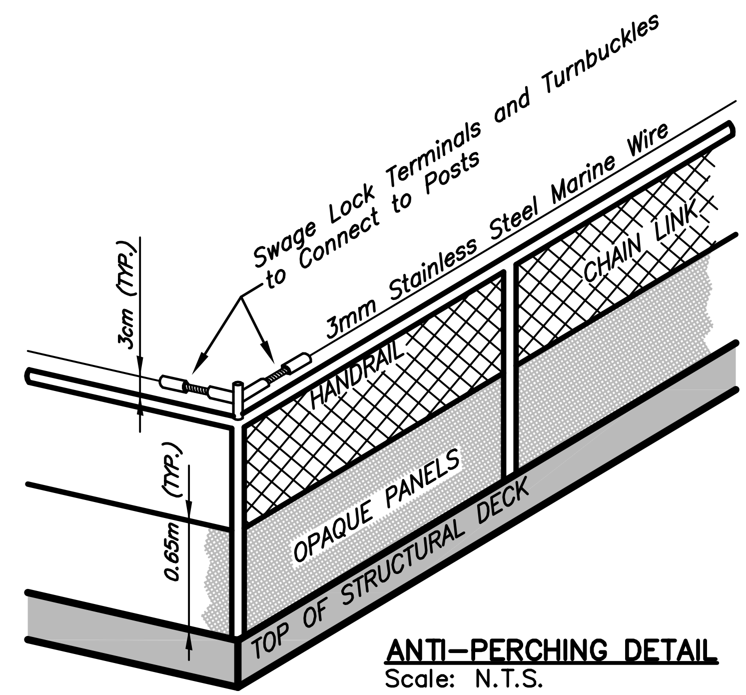

ANTI-PERCHING DETAIL
Scale: N.T.S.

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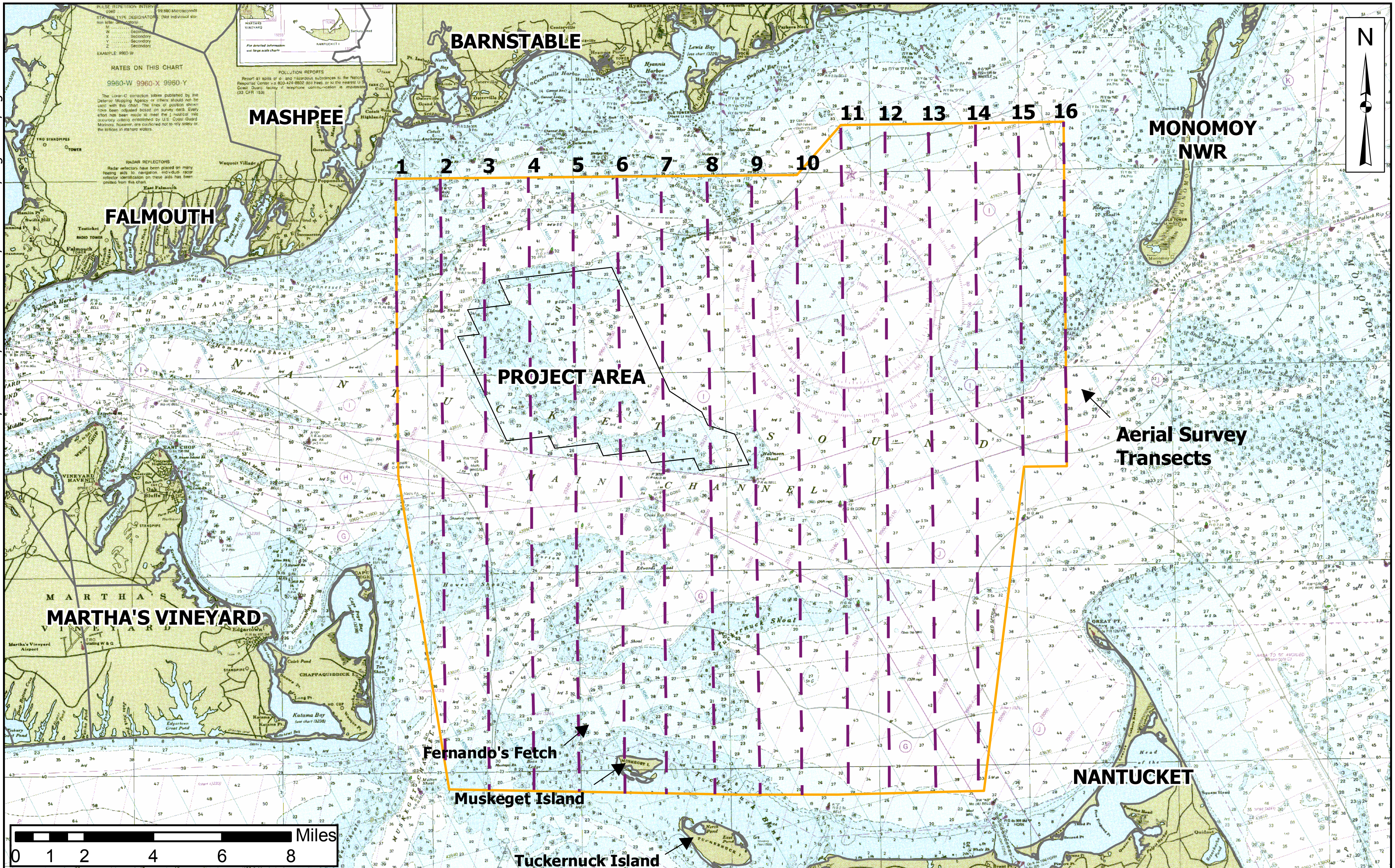
Cape Wind Project

Anti-Perching Detail

Figure 3



CAPE WIND AVIAN MONITORING PLAN

Nantucket Sound, Massachusetts

Legend:
- Survey Transects
- Study Area Boundary
- Project Area

Flight Plan for Winter Sea Ducks and Waterbirds

Figure 4

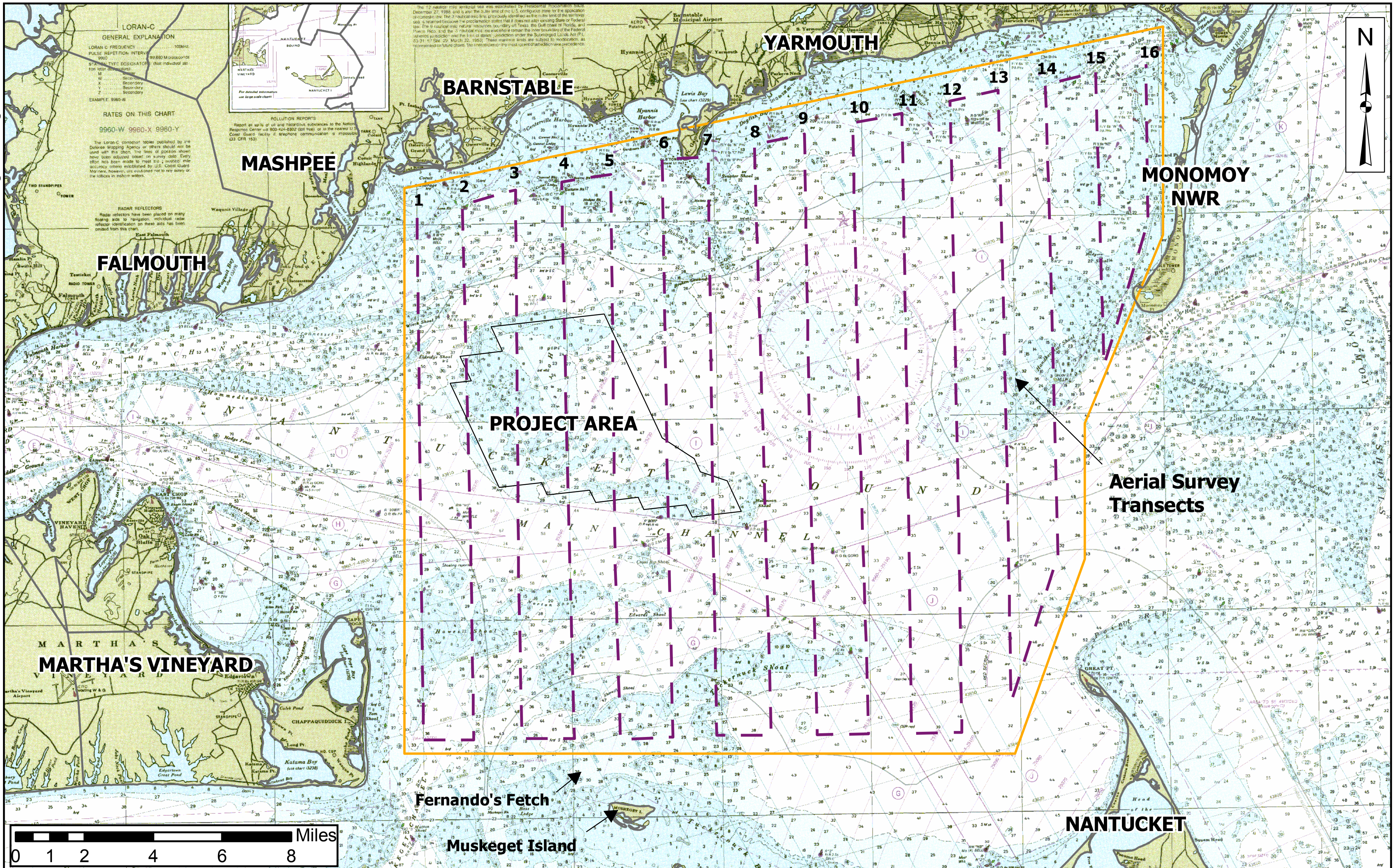
Scale: 1:260,000

Source: 1) NOAA Chart #13229 2) ESS, Approximate Site Boundary

ESS Group, Inc.

Engineers Scientists Consultants

Location: J:/E159-000/Birds Bats 2005/Avian MAS/FlightPath/Fig 5-7.mxd



CAPE WIND AVIAN MONITORING PLAN
Nantucket Sound, Massachusetts

Legend:
Survey Transects
Study Area Boundary
Project Area

Flight Plan for Tern Breeding and Staging Period

Figure 5

Scale: 1:260,000
Source: 1) NOAA Chart #13229 2) ESS, Approximate Site Boundary

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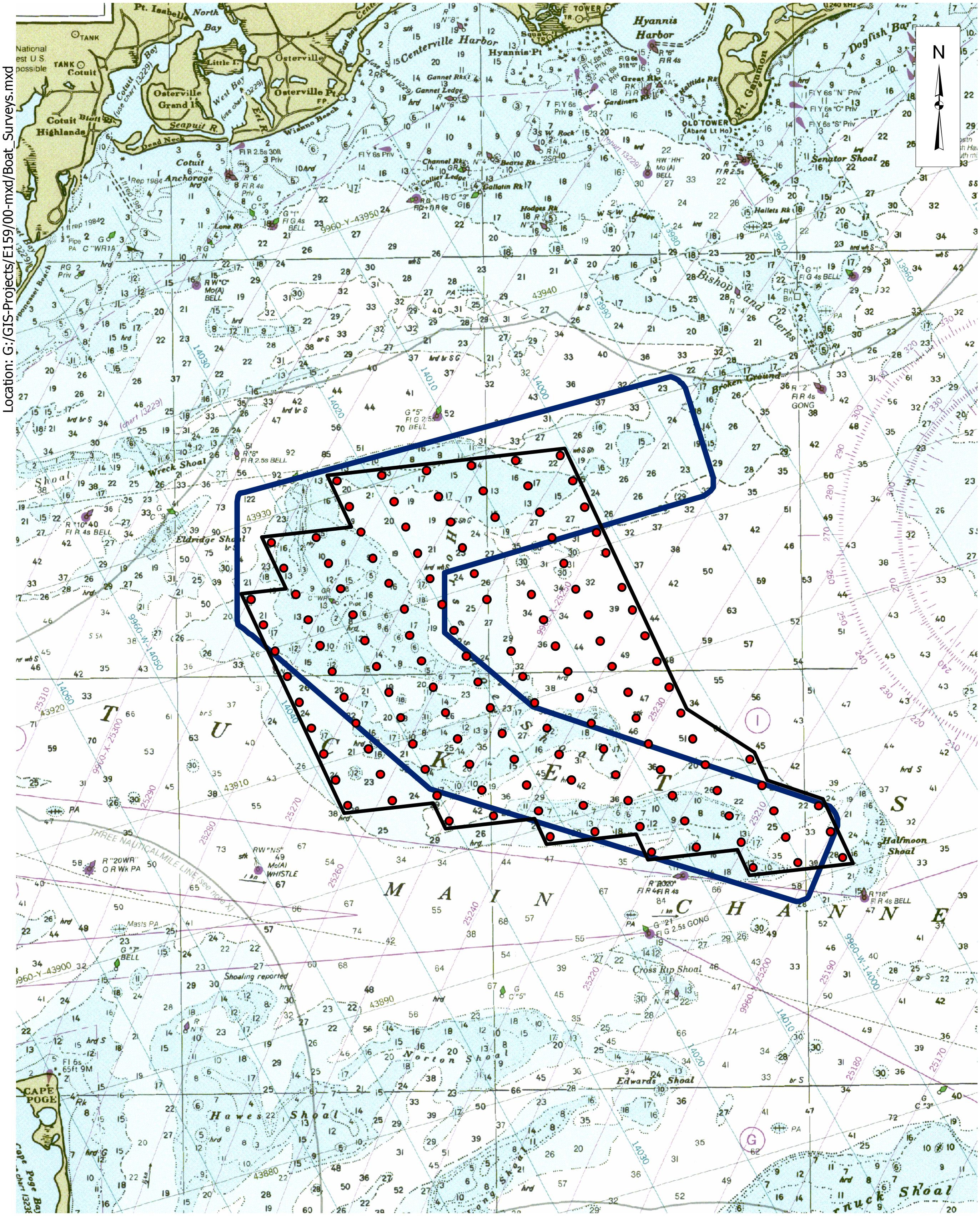
Location: J:/E159-000/Birds Bats 2005/Avian MAS/FlightPath/Fig 5-7.mxd

Location: G:/GIS-Projects/E159/00-mxd/Boat_Surveys.mxd



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CAPE WIND AVIAN MONITORING PLAN
Nantucket Sound, Massachusetts

Scale: 1" = 10,000'

Source: 1) NOAA, NOAA Chart Nantucket Sound and Approaches, 2001 2) ESS Site Boundary, Turbines, 2006

Legend

- Wind Farm Boundary
- Approximate boat survey route
- Proposed wind turbines

Boat Survey Route

Figure 6

Appendix C

Response to Comments on and Addendum to the Roseate Tern Population Viability Analysis

Response to Comments on and Addendum to the Roseate Tern Population Viability Analysis

Responses to Comments on and Addendum to the Roseate Tern Population Viability Analysis

The following represents the applicant's responses to comments on the Roseate Tern PVA and the new runs detailed in the PVA addendum below, result from updated population trends through 2007. These data were not available at the time of the original modeling. As such, although the responses to comments and new runs represent the most accurate analysis based on currently available data, the previous results in the 2007 FEIR were based on the best available scientific data at the time and consultations with federal and state wildlife officials and the Roseate Tern Recovery Team.

Source: Ian Nisbet, Submitted to U.S. Fish & Wildlife, New England Office, January 8, 2008

1. Page 9-10—The PVA uses a value 1.056 for the number of young produced (F_B). This is stated to be "the mean annual productivity (fledged young) rate for male-female pairs from 1998-2005.....calculated from overall productivity data (Recovery Team unpublished data)." I believe that this estimate is much too low. I do not have 1998 productivity data to hand, but I have the Recovery Team's Table 34, compiled in 2006 and including productivity estimates for most colonies from 1999-2005. Weighting the productivity estimate for each site-year by the number of pairs, the mean productivity is 1.150 for all U.S. colonies with data in Table 34, or 1.164 for the five colonies represented in Figure BA-6. These figures represent means over male-female and female-female pairs. Using Arnold's figures of 10% female-female pairs with productivity one-quarter of that of male-female pairs, these values convert to 1.247 and 1.262, respectively, for F_B. Arnold's lower estimate for F_B may have resulted from the use of simple averages instead of weighted averages of site-year values for productivity (productivity is consistently higher at larger colonies).

Response: The number of young produced (F_B) has been recalculated using all current available data from all US colonies (Mostello 2008 Table 34) then updated in a new run of the PVA model. The value is now 1.239 and associated variability, calculated as detailed in the original PVA report, is 0.119.

2. Page 10—I have not attempted to recalculate the output of the PVA using the parameters that I suggest, but I suspect that my proposed increases in productivity and in the frequency of years with "Best Case" parameters would yield a model closer to long-term balance than Arnold's, in which mean recruitment is substantially less than mean mortality. It may well be that a model with long-term balance would be more sensitive to small changes in survival than Arnold's model, which predicts rapid extinction with or without perturbations.

Response: The output from the new alternative run of the PVA does suggest reduced risk for all scenarios, in comparison with the original PVA (see PVA addendum at the end of these comments).

3. Page 23—Adult survival for the "best case" scenario is estimated as 0.8700 "from survival rates reported in Lebreton et al. 2003 and J. Hatch pers. comm." I do not know what additional information Hatch may have contributed, but the mean value of the estimates in Table 10 in Lebreton et al. (2003) is actually 0.8607 (omitting the hurricane year 1991-92 and the low value for 1994-95 which is used as the "worst case" scenario) or 0.8920 if the low value for 1968-69 is omitted also, which it probably should be because the earliest estimate in a multi-year mark-recapture study is often anomalously low.

Response: Although this value 0.8700 was developed in consultation with experts, including the members of the Roseate Tern recovery team, we concur with Nisbet's observation that the 0.8700 is indeed too low to be supported by the data of Lebreton et al. (2003). Since, as Nisbet points out, available data suggest a value of 0.8920 for adult survival we now utilize this data driven value. This was incorporated into the alternative run of the PVA model, along with a new juvenile survival value (0.7109) calculated using the correlated vital rate approach detailed in the original PVA report (see also comment 6).

Variance estimates were also recalculated for these vital rates and applied across all scenarios (see the PVA Addendum below).

4. Page 23—I question the statement on page 7 that "Most researchers believe that the short period of growth experienced from 1988 to 2000 was an anomaly and the current negative growth trajectory is more realistic." The period from 1988 to 2000 was not "short". Historically, the Roseate Tern population in this region has alternated between long periods of increase and shorter periods of decline (Nisbet and Spendelow 1999, extended with data in Figure 2). The causes of these changes are not understood and both have to be taken into account in modeling, as is done in this PVA. However, I think that the ratio of 90:1 for the relative probabilities of occurrence of the "Recent trend" and "Best-case" scenarios (Table 1) is too large.

Response: This statement reflected the general consensus of the Roseate Tern Recovery Team (RTRT) at the time that the PVA was developed and was based on many conversations with members of the RTRT. Although we have not been made aware of a new consensus of the RTRT, data from Gochfeld et al. (1998), Lebreton et al. (2003), and unpublished, updated data through 2007 from Mostello (2008, Table 34), support Nisbet's suggestion of extended periods of growth followed by short periods of decline may be typical. To incorporate this, a new ratio of the "best case", "worst case" and "recent trends" (now called 1999-2005) has been incorporated in the new alternative run of the PVA model. This is based empirically on population numbers from Gochfeld et al. (1998), Lebreton et al. (2003), and unpublished data from Mostello (2008, Table 34). Details of the calculation are given in the PVA Addendum below. The new ratios are: 69% "best case", 26% "worst case" and 5% "1999-2005" (previously "Recent Trends"). This new ratio of scenarios reflects the opinion of Nisbet that "the Roseate Tern population in this region has alternated between long periods of increase and shorter periods of decline" and is based on 17 years of data.

5. Page 23—The reduction of the value used for overwinter survival of fledglings by 28% in hurricane years (page 12) is inappropriate. The estimates tabulated in Table 11 of Lebreton et al. (2003) indicate that this parameter was reduced by at least 70% in the hurricane year 1991 -92.

Response: This value was used as reduction of survival of juveniles ***in addition to*** *the 24% reduction that was observed for adults (Lebreton et al. (2003)). Therefore the juvenile value was to be reduced by 52% overall during a hurricane year. However, in response to this comment, recalculation of the observed reduction for juveniles from Table 11 of Lebreton et al. (2003) converted these two-year values to annual values prior to the calculation and produced a more robust yearly estimate of 61% total reduction. This reduction was incorporated into the new runs of the PVA model (see PVA Addendum below).*

6. Page 23—I question the value of 0.8719 adopted for adult survival in the "Recent trend scenario." This value is higher than that used for adult survival in the 'best case" scenario. This is explained on page 10 as the result of assuming a fixed ratio of 0.68 between juvenile and adult survival. The basis for this assumption is unclear: the cited source (Spendelow et al. 2002) is not in the bibliography. There is no biological basis for predicting a functional relationship between juvenile and adult survival, and the actual values presented by Lebreton et al. (2003: Tables 10 and 11) suggest very wide variability in this ratio. It seems more plausible to me that the abrupt change in population growth rates that took place in 2000 resulted from a change in adult survival rather than a change in juvenile survival, whose effects on breeding numbers would have been spread over several years. This issue is important because the sensitivity analysis indicates that adult survival is the most important parameter in the model.

Response: Using the new "best case" value for adult survival of 0.8920 (see RTC#3) is higher than that for the "recent trends" scenario (now called "1999-2005") (0.8719). The justification for the ratio of 0.68 between adult and juvenile survival was based on seven years of unpublished data from Falkner Island, *CT (1988-1995; Spendelow, unpublished). Data from Tables 10 and 11 of Lebreton et al. (2003) were reanalyzed and (when the two year juvenile survival estimates are converted into annual values, taking the square root) the ratio between the vital rates varied between 0.39 and 0.85, with a mean of 0.68, supporting the original PVA analysis of Falkner data. Such a relationship could follow if the main mortality factors affecting both adults and juveniles were the same but juveniles were less able to cope, for example because of inexperience (e.g. Watson and Hatch 1999). The probability associated with the "1999-2005" scenario in the new run of the PVA is much reduced (5% from 90% in the original PVA) and the "best case" estimate of adult survival is now higher than that for "1999-2005".*

Source: Anonymous, March 22, 2007

1. Pages 3–4 of MDFW comments on Cape Wind FEIR, 3/22/07—The model is most sensitive, of all parameters, to the annual adult survival rate (S_B). The value selected for this parameter, however, is not realistic: the selected value is higher in the "recent-trend" scenario (the actual, current trend), under which Roseate Terns are declining, than it is in the best-case scenario, under which the population would be growing. Despite the explanation provided (p. 10), these inputs should be adjusted; a revised PVA is warranted.

Response: This comment has been addressed in RTC#3 of Nisbet, above.

2. Pages 4 of MDFW comments on Cape Wind FEIR, 3/22/07—This model (as is) shows that even under a "no-take" scenario, quasi-extinction probability is very high (9% at 15 years) and even very low levels of take may have a measurable effect on quasi-extinction probability. The take of just 20 males per year nearly doubles the "no-take" rate at 15 years. Proper adjustment of the adult annual survival rate should result in an increase in quasi-extinction probability. However, there is a lot of uncertainty about the relative occurrence of each scenario (pp. 19-20); thus, this introduces a lot of uncertainty about the results.

Response: This comment has been addressed in RTC#2 and 6 of Nisbet, above. In addition, a distribution of collision mortality (from Table 3 from Hatch & Brault (2007)) has been used in place of deterministic collision scenarios (e.g. 1, 5, 20, 100 in the original PVA). This incorporates the best possible estimates of collision mortality. See PVA Addendum below.

3. Pages 4 of MDFW comments on Cape Wind FEIR, 3/22/07—A revised PVA is warranted to rectify the flaw mentioned above.

Response: An alternative PVA run has been performed: see PVA Addendum below.

Source: US Fish & Wildlife Service, February 2008

1. Page 5-27—Roseate numbers have increased 22% since year 2005 (from 3,115 peak breeders in 05 to 3,803 in 07. Arnold says she used peak numbers of pairs to compute the no. of males, 3,100 in 05 but she would have had to have used total numbers of pairs (3435) to come up with that figure, because the sex ratio is .45 males; .55 females. In any event, the roseate population is significantly more robust than just two years ago.

Response: The most recent population estimates (2007) for the US roseate tern have been used in the new PVA model runs (see PVA Addendum below). This is an estimate of 3826 pairs (data from Mostello 2008, Table 34); the sex ratio (45% male) is used to compute the number of males in the PVA as before (giving 3443 males).

2. Page 5-27—I am confused at how the model predicts a virtual doubling of the extinction risk between years 25 to 50, even though it apparently considers Cape Wind to be a 20 year project, and any incidental collision mortality should be removed from the model at years >21.

Response: The original PVA model was run for project lives of both 20 and 30 years. In the model, individuals were taken according to the loss scenario for 20 and 30 years of the model run, respectively. Quasi-extinction probabilities are calculated based on the proportion of iterations for which the population size drops below quasi-extinction (500 or lower males in the population) in each year of the model run. Given that all populations start off at the same level, even with the potential wind farm mortality, few populations drop low enough to qualify as being quasi-extinct in the first years of the model run. However, eventually population sizes get low enough that we start seeing populations go extinct even without the wind farm losses. Also, factors that impact the population in the first 20 years will continue to impact the population later on in a couple of different ways. For example, if breeders were lost, they will not be immediately replaced; new individuals will need to mature to breeding age. In addition, the original PVA had a downward trajectory, so, there is nothing to bolster the population once the wind farm mortality stops. The impact of the losses of individuals from wind farm mortality acts to expedite the overall time to quasi-extinction.

3. Page 5-27—The model does not take into consideration the potential increase in the number of breeding roseate terns (or the increase in productivity) that could result from the implementation of the Bird Island restoration project, which is proposed to be partially funded as mitigation by Cape Wind.

Response: The new alternative run of the PVA model (see PVA addendum below) incorporates the maximum success of the Bird Island Restoration Project by adding 84 individual males (all new pairs assumed to male-female pairs) into the model at year 1. Additions are made in year 1 since this is both the most likely time at which benefits from the Bird Island Restoration Project will occur in respect to the progress of the Cape Wind Project, and which also gives a scenario in which the maximum beneficial effect of this restoration can be compared to model runs not including the effects of restoration. A scenario where no individuals were added, was also run. This scenario represents a potential worst-case scenario.

4. Page 5-27—Given that Nisbet (2008) has offered an alternative range of outcomes for the Collision Risk Assessment conducted by Hatch and Brault, as well as refined estimates of PVA model inputs (such as increased number of young produced), it would useful to run a revised PVA.

Response: An alternative PVA run has been performed: see PVA Addendum below. In this model, a distribution of collision mortality (from Table 3 from Hatch & Brault (2007)) has been used in place of deterministic collision scenarios (e.g. 1,5, 20, 100 in the original PVA). In addition, a second run incorporating the refinements in Hatch's response to comments on the original Hatch & Brault (2007) model has been performed.

PVA Addendum

This addendum includes new runs of the Roseate Tern PVA that results from updated life-history data not originally available at the time the original PVA was developed. As such, although these new runs represent the most accurate analysis based on currently available data, the previous results in the 2007 FEIR were based on the best available scientific data at the time and consultations with federal and state wildlife officials and the Roseate Tern Recovery Team. This model should be viewed in tandem with the original model as an alternative based on current data as of April 2008.

This section details 12 new model runs. These incorporate, no take scenarios (i) and collision distribution estimates based on (ii) 20 and (iii) 30 year project lives for:

1) PVA model run using collision risk estimates from Hatch & Brault (2007, Table 3), without any effects of the Bird Island Restoration Project.
2) PVA model run using collision risk estimates from Hatch & Brault (2007, Table 3), with maximum beneficial effect of the Bird Island Restoration Project (84 new breeding males in year 1).
3) PVA model run using collision risk alternative estimates in Hatch's response to comments without any effects of the Bird Island Restoration Project.
4) PVA model run using collision risk alternative estimates in Hatch's response to comments with maximum beneficial effect of the Bird Island Restoration Project (84 new breeding males in year 1)

The 84 new breeding males are estimated to arise from 100% success of the Bird Island Restoration Project were assumed to all form male-female bonds and none were assumed to have bred previously elsewhere, thus increasing the fertility of the population and population size to the maximum extent.

The Hatch & Brault (2007, Table 3) distribution was converted into a standard probability distribution and in each year and iteration of the project life an estimated loss (collision mortality) was randomly selected from 10,000 values of this distribution. We maintain the original whole individual based loss scenario from the earlier PVA by rounding fractions to the nearest individual (whole number). Hatch's alternative estimates in the response to comments were incorporated by multiplying the values in this 10,000 value distribution by 2.48 (revision factor), so for example a value of 0.83 individuals would then become 2.0584.

All models were rerun with the following changes to vital rates and scenarios based on the comments responded to above:

- Number of young produced (F_B) = 1.239 (variance = 0.119)
- Adult survival in the "best case" scenario = 0.8920, juvenile survival "best case" = 0.7109; new adult variance estimates (0.0083) and juvenile survival variance estimates (0.0155) were applied to adult and juvenile survival in all three scenarios
- A new ratio of the relative probabilities of occurrence of the "best case", "worst case" and "recent trends" (now called "1999-2005") of 69%:26%:5%.
- Juvenile survival was discounted by a total of 61% total during hurricane years
- The starting population was 3443 males (not including any individuals added as a result of the Bird Island Restoration Project).

Number of young produced was calculated from all available data for US colonies from the Table 34 of Mostello using weighting averages by colony size.

Adult survival for "best case" scenario was calculated from Lebreton et al. (2003) using data from 1988-1998 omitting the hurricane year 1991-92, the low value for 1994-95 (used as the "worst case" scenario) and the low value for 1988-89, as this latter value is possibly biased as it is the first year of a mark-recapture analysis (see Nisbet comment #3).

New adult variance estimates (0.0083) were calculated from “best case scenario” such that 90% of the values estimated from a beta distribution were above the lowest annual adult survival value reported in Lebreton et al. (2003) for all years except hurricane years (0.7648), and 90% of values were below the highest value from the same source (0.9840). The same approach was used to generate new variance estimates for juvenile survival, using the lowest (except hurricane) value of 0.2354 and highest value of 0.8646 (converted to annual estimated from Lebreton et al. (2003), Table 11). These new variances were applied to adult and juvenile survival in all three scenarios, as per the original PVA.

The new ratio of the relative probabilities of occurrence of the “best case”, “worst case” and “recent trends” (now called “1999-2005”) is based empirically on population numbers from Gochfeld et al. (1998), Lebreton et al. (2003), and unpublished data from Mostello (2008, Table 34). Annual growth rates from 1990-2007 are calculated from the yearly data on population size. Each of the three scenarios simulates a specific growth rate (see original PVA, Table 3). For each year from 1989-2007, the absolute difference between each scenario growth rate and each annual growth rate was calculated. The year that was closest to a certain scenario was said to “mimic” that scenario. The proportion of years that mimic 'best case', 'worse case' and ‘1999-2005' scenarios were: 69% “best case”, 26% “worst case” and 5% “1999-2005”. This ratio was therefore instructed by the available data in a way that should simulate the actual variability in growth rates of the US roseate tern population most appropriately. The implementation of these scenarios differs in the new runs from that in the original PVA to reflect the fact that each scenario now represents an annual estimate of vital rates. In the new runs, for every model iteration vital rates were selected from one of the three scenarios separately for each year of the model run, so that each year had the same probability of following a certain scenario as observed in the data (detailed above). In the original PVA, scenarios had represented long time periods (6-10 years) and therefore each iteration of the model was run for 50 years with the same scenario. The original approach was fully justified given the available data at the time but the approach in the new runs is best supported by the newly available life history data.

Recalculation of the reduction in juvenile survival during hurricane years was calculated using the observed reduction for juveniles from Table 11 of Lebreton et al. (2003). This value was converted to an annual value (square rooted) prior to the calculation and produced a 61% total reduction in juvenile survival during a hurricane year.

The starting population was the estimated US roseate tern population from Table 34 of Mostello.

A summary of the new vital rates and annual growth rate (lambda) for the three scenarios is given in the table below:

	1999-2005 Scenario	**Worst-case Scenario**	**Best-Case Scenario**
Annual growth rate (lambda)	***0.9621***	***0.9166***	***1.0494***
Probability of occurrence	***5%***	***26%***	***69%***
Vital Rate			
$\mathbf{F_B}$	1.239 (0.119)	Same as 1999-2005	Same as 1999-2005
$\mathbf{m_1}$	0.0323 (0.0004)	Same as 1999-2005	Same as 1999-2005
$\mathbf{m_2}$	0.5669 (0.0133)	Same as 1999-2005	Same as 1999-2005
$\mathbf{m_3}$	0.8351 (0.0785)	Same as 1999-2005	Same as 1999-2005
$\mathbf{S_B}$	0.8719 (0.0083)	0.7648 (0.0083)	0.8920 (0.0083)
$\mathbf{S_I}$	0.5929 (0.0155)	0.6151 (0.0155)	0.7109 (0.0155)
R	0.45	Same as 1999-2005	Same as 1999-2005

Results

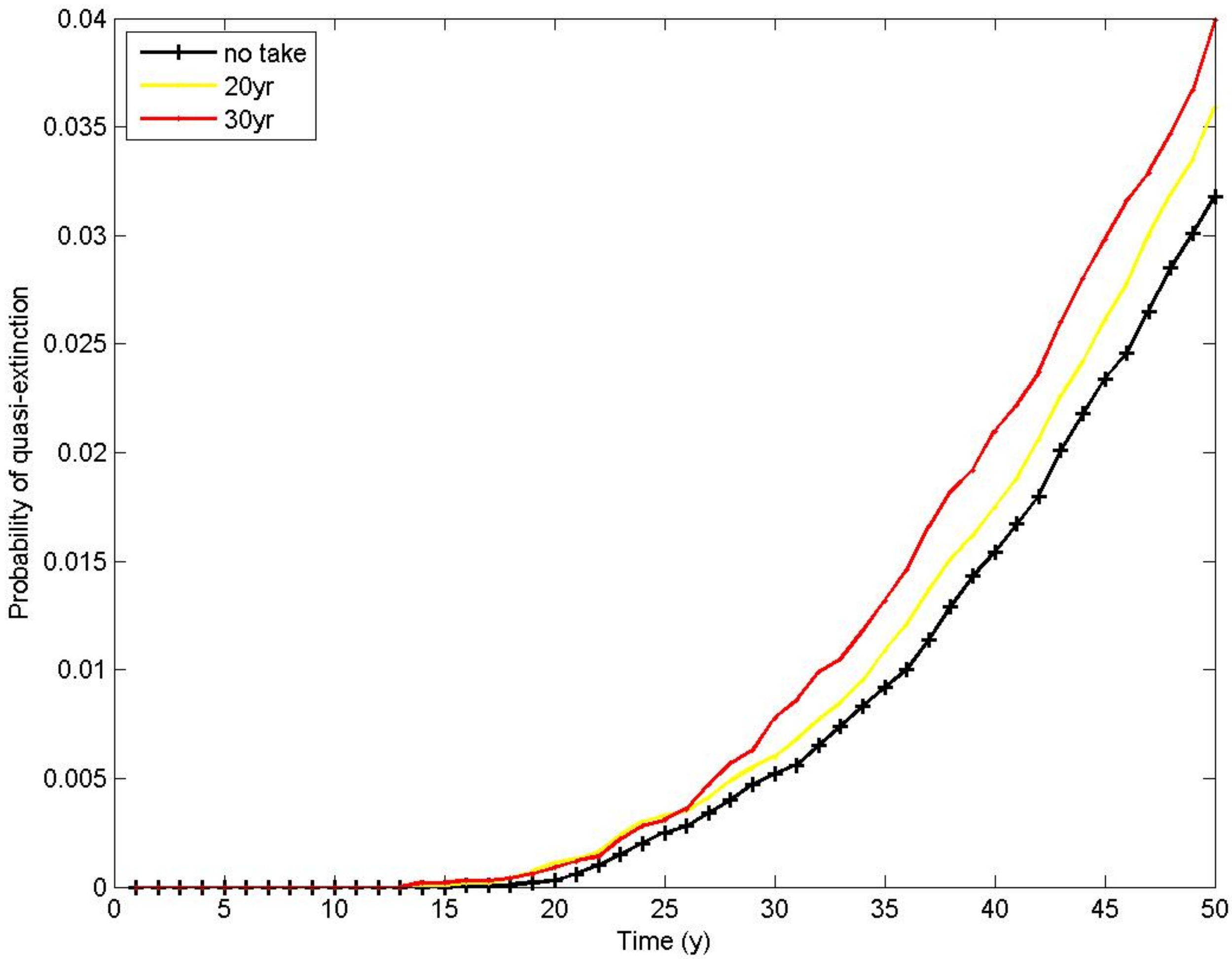
The new results are shown in the pages that follow. For each run of the model, one table (Probability of quasi-extinction evaluated at 15, 25, and 50 years, analogous to Table 4 in the original PVA and median minimum population size replaces expected minimum population size presented in the original PVA) and two figures (change in quasi-extinction risk over time (cf. Figure 4a, original PVA) and relationship between quasi-extinction and quasi-extinction threshold at 50 years (cf. Figure 5, original PVA) are given. The evaluation in this latter figure is performed at 50 years because extinction probabilities are much lower in the new results.

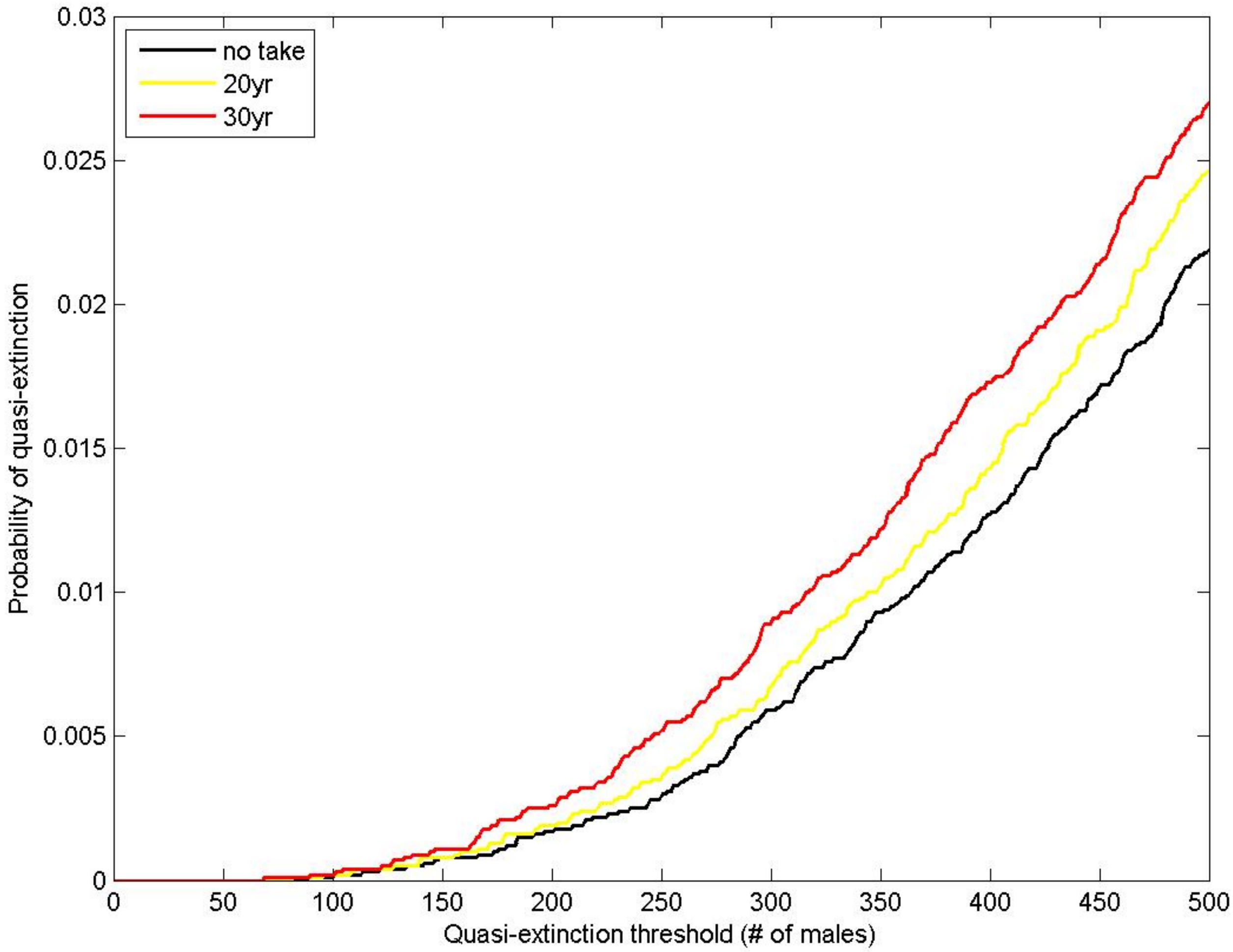
Expected population size is defined as the mean of the minimum population size across model iterations. In the original model, we evaluate this value at 15, 25, and 50 years. In this version we use median minimum population size at 50 years (the end of the model run) instead of expected minimum population size to more accurately represent the central tendency for minimum population size because the population sizes are not evenly distributed but skewed towards small populations with approximately 13% of the iterations having extremely high minimum population sizes above 10,000 individuals.

Please note that the rise in the extinction probability between 25 and 50 years represents the populations that have been slowly decreasing finally reaching low enough population numbers that they drop below 500 individual males (quasi-extinction). However, in this model extinction probability is low throughout the model run, so even the increase in probability in the last time never exceeds a 4% probability of extinction for this roseate tern population.

1) PVA model run using collision risk estimates from Hatch & Brault (2007, Table 3), without the any effects of the Bird Island Restoration Project.

	Evaluation Year			**Median minimum population size**
	15	**25**	**50**	
Mortality Estimate				
No Take	0.0% (0.000)	0.2% (0.0025)	3.2% (0.0318)	3547
H&B distribution, 20 year project life	0.0% (0.000)	0.3% (0.0029)	3.3% (0.0333)	3507
H&B distribution, 30 year project life	0.0% (0.000)	0.3% (0.0028)	3.5% (0.0347)	3483

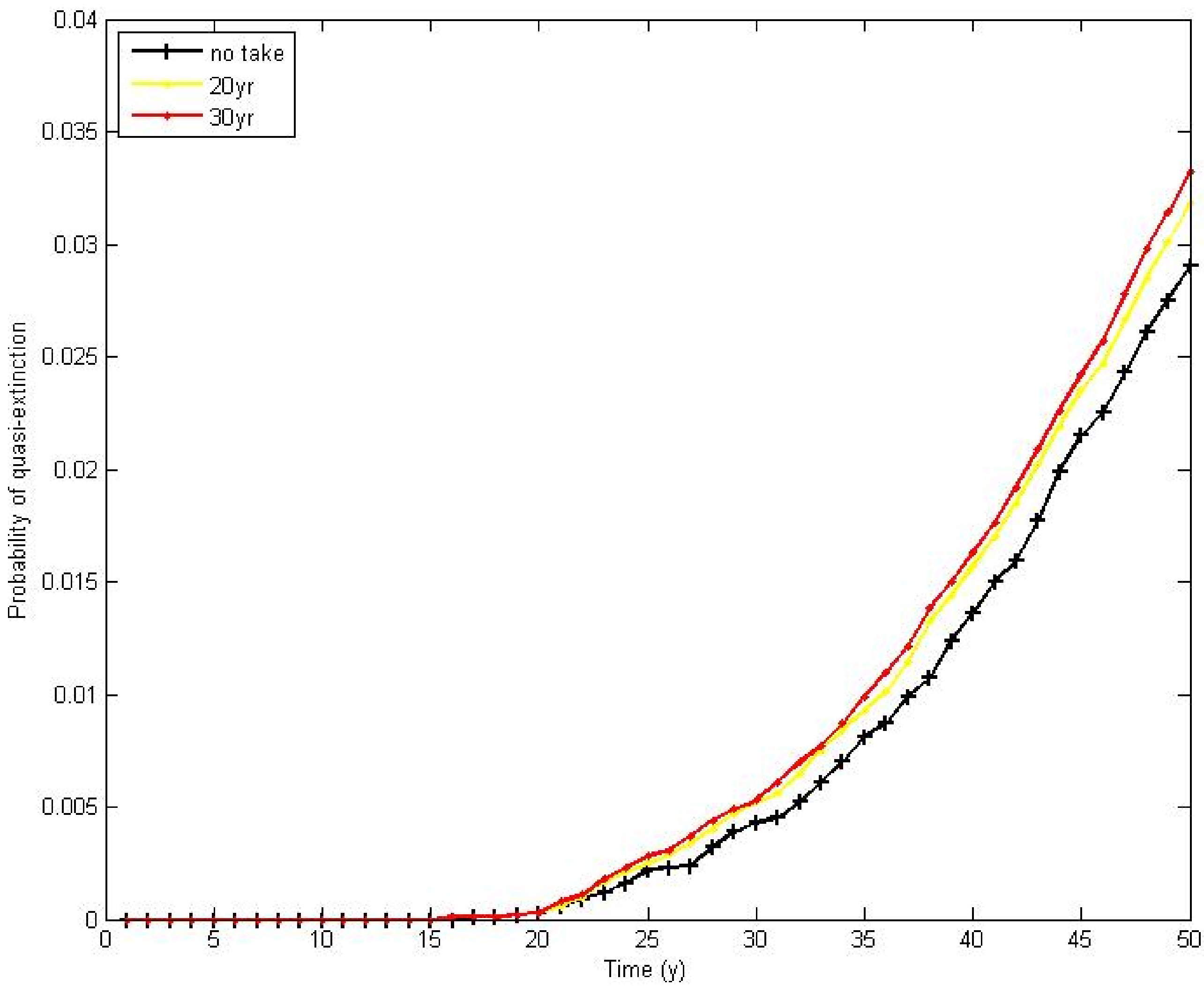


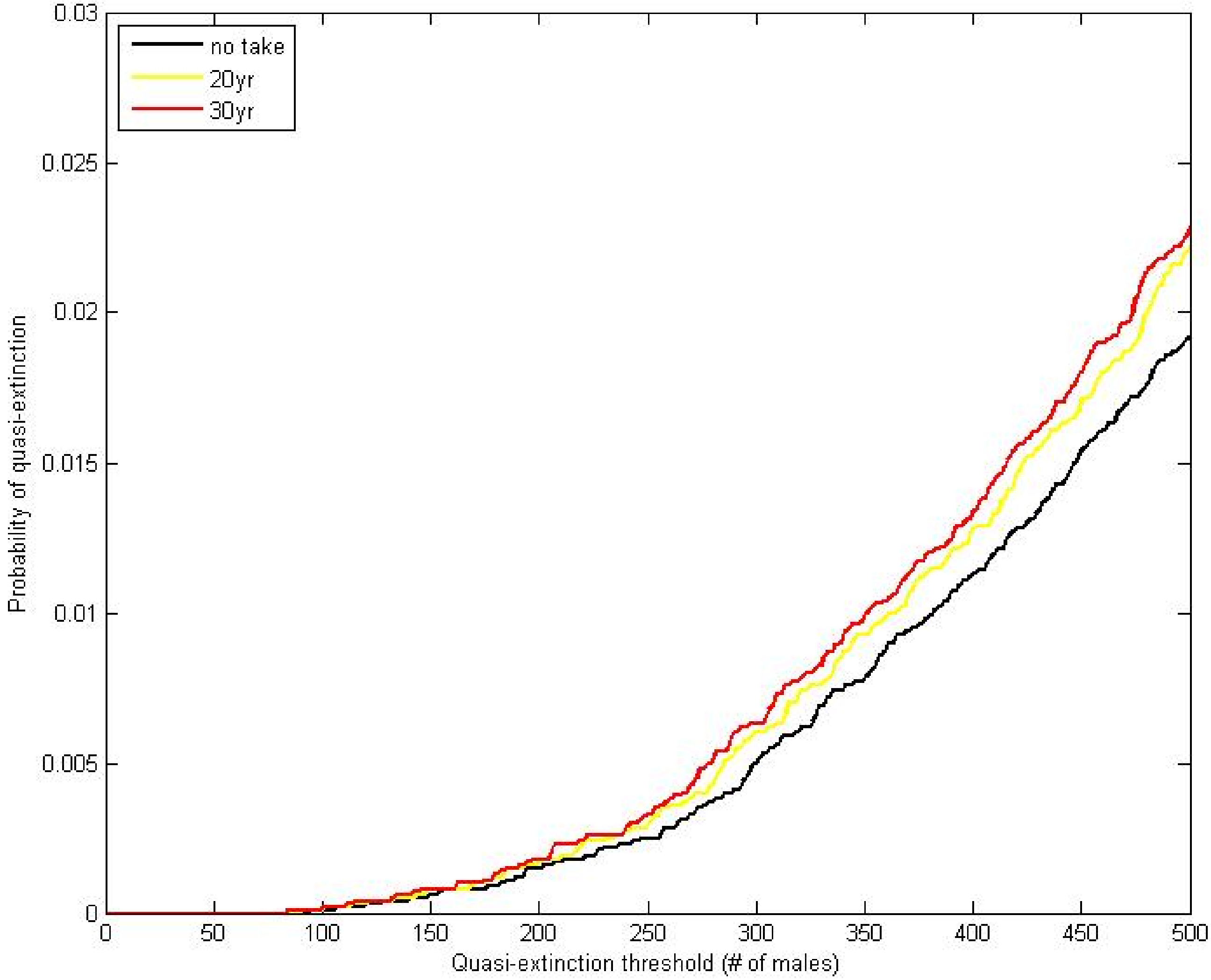


PVA model run using collision risk estimates from Hatch & Brault (2007, Table 3), without any effects of the Bird Island Restoration Project.

2) PVA model run using collision risk estimates from Hatch & Brault (2007, Table 3), with maximum beneficial effect of the Bird Island Restoration Project (168 individuals in year 1).

	Evaluation Year			**Median minimum population size**
	15	**25**	**50**	
Mortality Estimate				
No Take	0.0% (0.0000)	0.2% (0.0022)	2.9% (0.0292)	3720
H&B distribution, 20 year project life	0.0% (0.0000)	0.3% (0.0025)	3.2% (0.0318)	3565
H&B distribution, 30 year project life	0.0% (0.0000)	0.3% (0.0028)	3.3% (0.0332)	3549

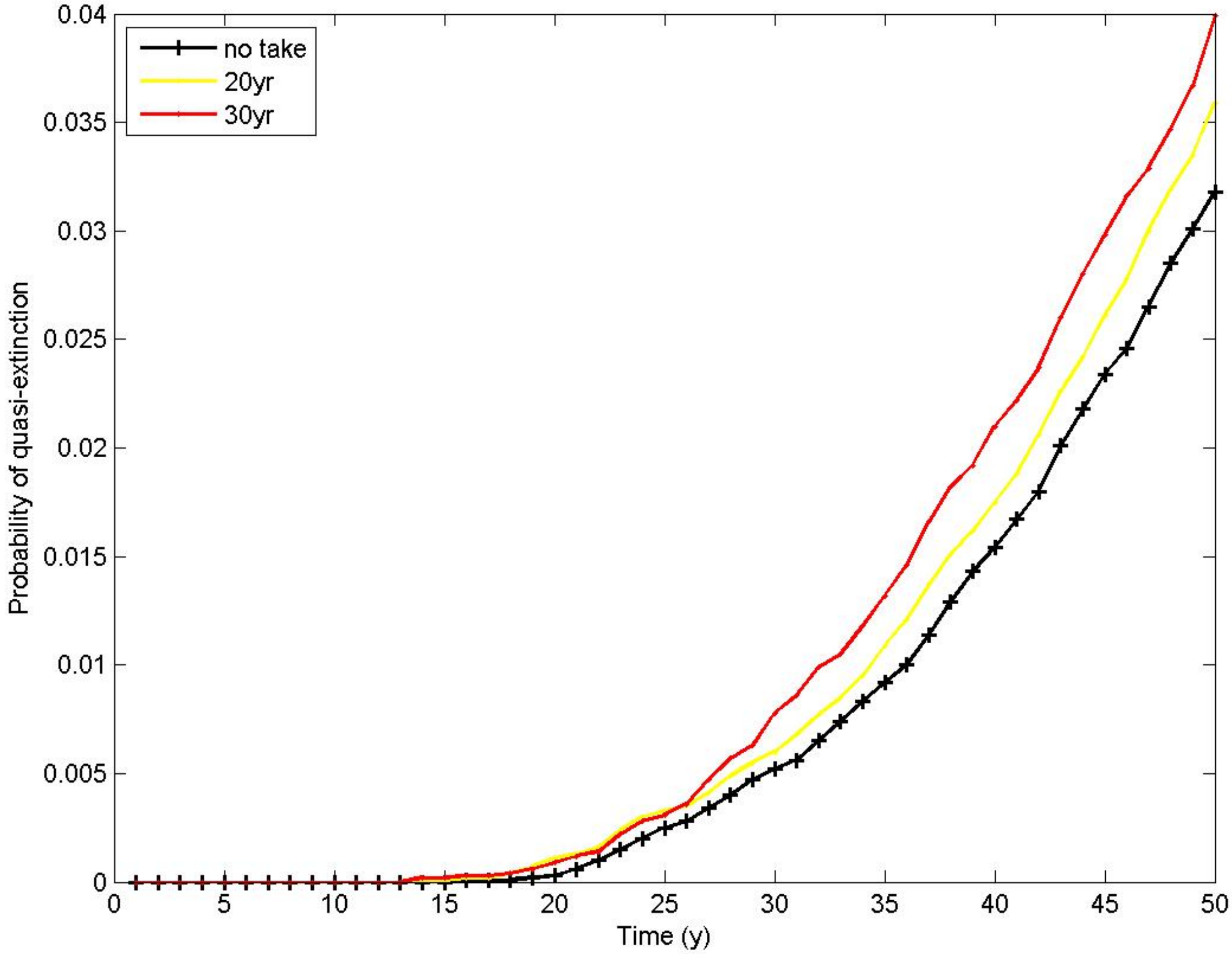


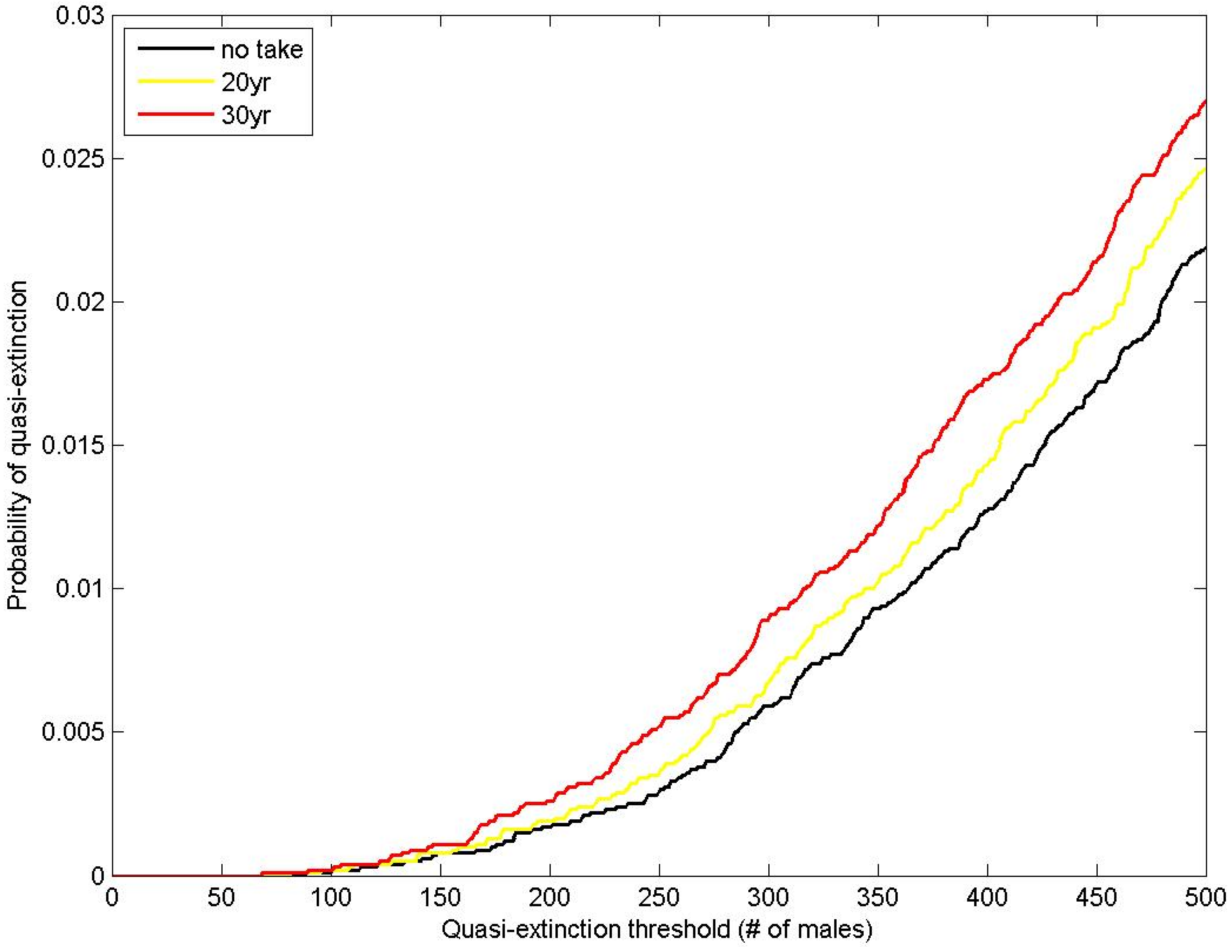


PVA model run using collision risk estimates from Hatch & Brault (2007, Table 3), with maximum beneficial effect of the Bird Island Restoration

3) PVA model run using alternative collision risk estimates in Hatch's response to comments without the effects of the Bird Island Restoration Project.

	Evaluation Year			**Median minimum population size**
	15	**25**	**50**	
Mortality Estimate				
No Take	0.0% (0.0000)	0.2% (0.0025)	3.2% (0.0318)	3547
H&B distribution, 20 year project life	0.0% (0.0001)	0.3% (0.0033)	3.6% (0.0359)	3448
H&B distribution, 30 year project life	0.0% (0.0002)	0.3% (0.0031)	4.0% (0.0399)	3384

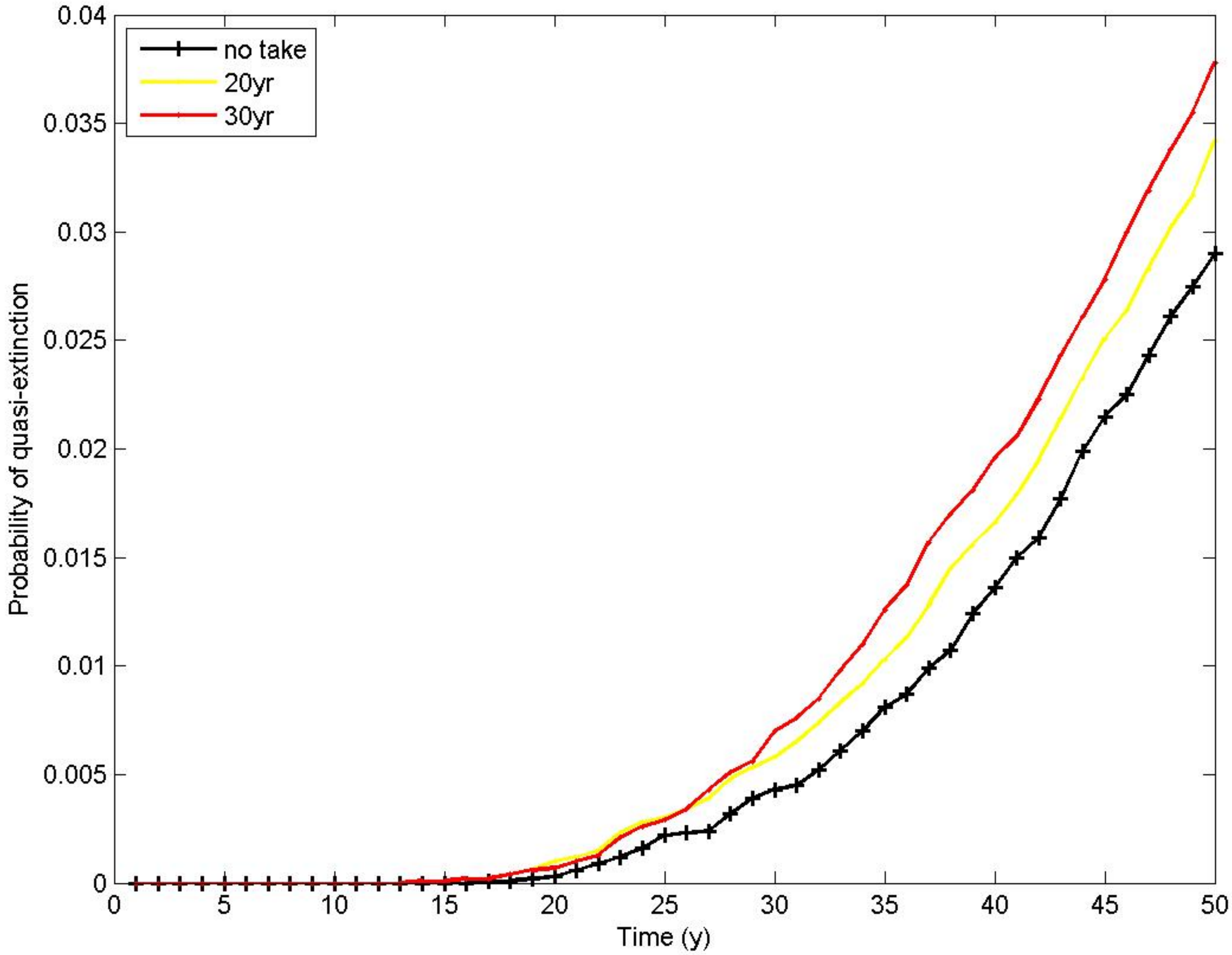


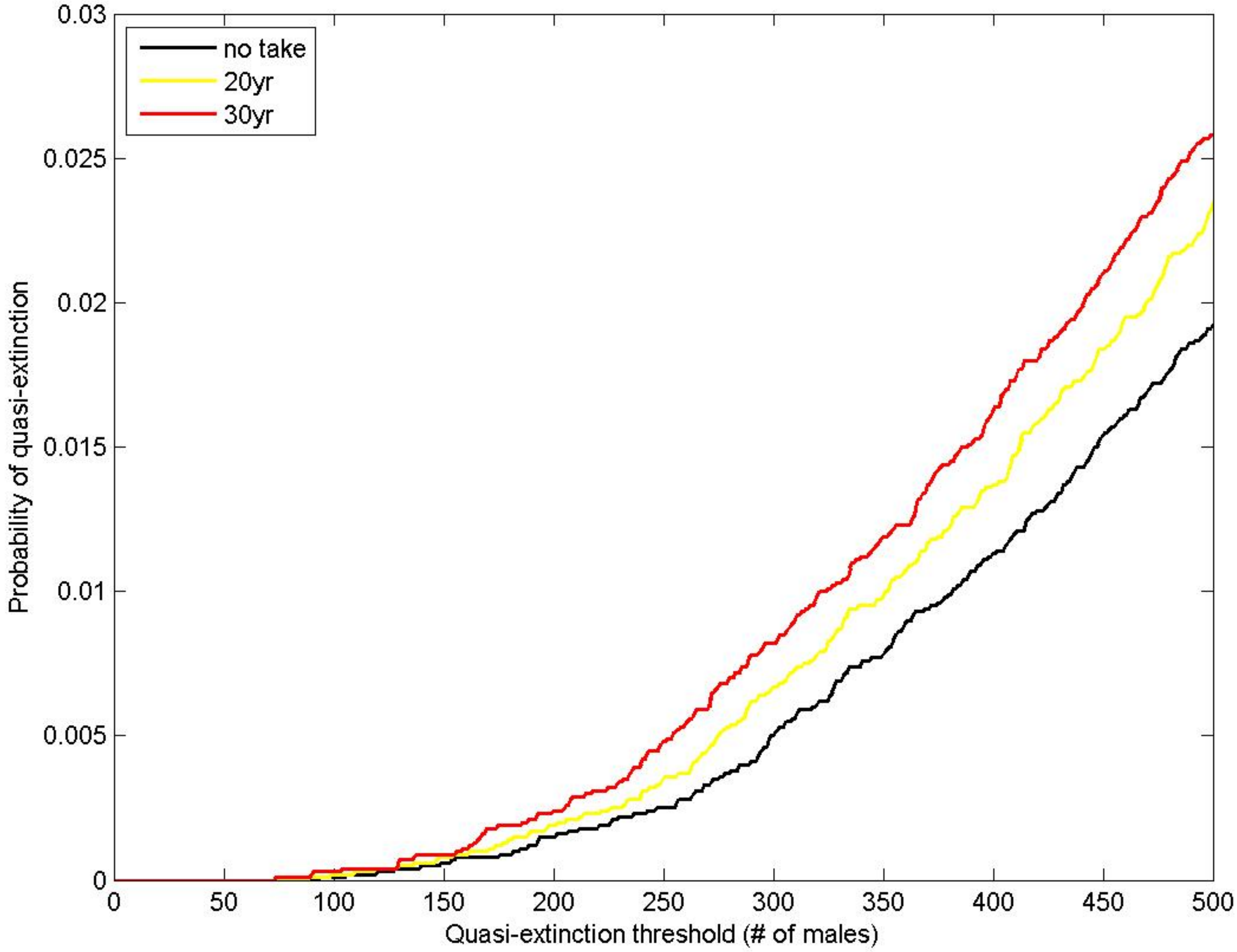


PVA model run using collision risk estimates updated in Hatch's response to comments without the effects of the Bird Island Restoration Project.

4) PVA model run using alternative collision risk estimates in Hatch's response to comments with maximum beneficial effect of the Bird Island Restoration Project (168 individuals in year 1)

	Evaluation Year			**Median minimum**
	15	**25**	**50**	**population size**
Mortality Estimate				
No Take	0.0% (0.0000)	0.2% (0.0022)	2.9% (0.0290)	3720
H&B distribution, 20 year project life	0.0% (0.0000)	0.3% (0.0030)	3.4% (0.0342)	3511
H&B distribution, 30 year project life	0.0% (0.0000)	0.3% (0.0029)	3.8% (0.0378)	3456





PVA model run using collision risk estimates updated in Hatch's response to comments with maximum beneficial effect of the Bird Island Restoration