Appendix 5.7-I

Biological Review of the Common Tern for the Cape Wind Project

APPENDIX 5.7-I
BIOLOGICAL REVIEW OF THE COMMON TERN
FOR THE CAPE WIND ENERGY PROJECT
NANTUCKET SOUND

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Figure 1 Study Area, Alternative and Other Important Features For the Cape Wind Project (Tern Locational data omitted from publicly distributed copies). -

1.0 INTRODUCTION

1.1 Massachusetts Endangered Species Act Regulation

This Biological Review was prepared at the request of the Massachusetts Environmental Policy Act (MEPA) Office in accordance with the Massachusetts Endangered Species Act (MESA) (M.G.L. c. 1331A) and its implementing regulations (321 CMR 10.00). The MESA prohibits the "taking" of any rare plant or animal species listed as Endangered, Threatened, or of Special Concern by the MA Division of Fisheries & Wildlife (M.G.L c.131A and regulations 321 CMR 10.00). The Natural Heritage and Endangered Species Program (NHESP), part of the Massachusetts Division of Fisheries and Wildlife, will be charged with reviewing the likely impact of proposed development projects on species of environmental concern in the study area.

The action under consideration is the construction, operation, and maintenance of an offshore wind energy project, proposed by Cape Wind Associates, LLC (the "Applicant" or "Cape Wind"), on Horseshoe Shoal in Nantucket Sound along with a submarine electric transmission cable system that connects the power to the mainland electric grid.

1.2 Species Considered

This Biological Review (BR) was requested for the Massachusetts-listed species of special concern, the Common Tern (*Sterna hirundo*). It resembles the Biological Assessment (BA) of the threatened Piping Plover and the endangered Roseate Tern prepared for the National Environmental Policy Act (NEPA) submission. Both the Roseate and Common Tern forage in the waters of Nantucket Sound and travel throughout the Project Area during the summer (late April – mid September). Both species often occur together, share many biological attributes and frequently cannot be distinguished by sight. Consequently, this BR shares many features with the account of the Roseate Tern (*Sterna dougallii*) which is presented in Appendix 5.7-H.

The Least Tern (*Sterna antillarum*) is also listed as a species of special concern in Massachusetts but the MEPA Office did not request a biological review for this species. Subsequently a reviewer of a draft of the BA has asked that information be included about Least Terns in this BR. In response to that request, this paragraph briefly summarizes information about Least Terns, including that obtained during the field studies of Roseate and Common Terns. The Least Tern is the most widely distributed tern in Massachusetts, where about 3000 pairs nest. In 2002, nearly 1000 pairs nested at 13 sites around Nantucket Sound (Mostello 2003). This tern is known as an inshore feeder and frequently nests on mainland beaches, where colony-sites are unstable. During the surveys of the study area in Nantucket Sound, 88 flying Least Terns were recorded, of which 3 were over Horseshoe Shoal. The highest flying individual was at 50 ft. Additional individuals were seen resting on the ground at Fernando's Fetch, and outside the study area, flying close to the mainland shore and foraging at Succonnesset Shoal.

1.3 Format of the Biological Review

A summary of the proposed action, site alternatives, and affected physical and biological environment is included in Section 2 of this review. Section 3 presents life history information for the species considered, including population status and trends, seasonal distribution, preferred food and feeding habits, flight behavior, known disturbances and mortality factors, and use of Nantucket Sound and the Project Area. Potential impacts of the proposed action on the Common Tern are discussed in Section 4, the management practices to minimize those impacts are discussed in Section 5, and the conclusion is presented in Section 6. Literature cited in this document and other relevant references are presented in Section 7.

2.0 PROPOSED ACTION AND ALTERNATIVES

2.1 Description of Proposed Action

The offshore wind energy project proposed by Cape Wind consists of the installation and operation of 130 3.6 megawatt (MW) Wind Turbine Generators (WTGs) with an associated Electric Service Platform (ESP) on

Horseshoe Shoal in Nantucket Sound. Two additional sites within Nantucket Sound have been evaluated as alternatives for construction of the WTG array. All three sites, depicted in Figure 1, are located outside of the Massachusetts' three-mile state jurisdictional limit, exclusively within federal waters of Nantucket Sound.

The WTGs will produce an average of 170 megawatts (MW) (up to a maximum output of 454 MW) of energy using the natural wind resources off the coast of Massachusetts. Wind-generated energy produced by the WTGs will be transmitted via a 33 kV submarine transmission cable system to the ESP centrally located within the WTG array. The ESP will then take the wind-generated energy from each of the WTGs and transform and transmit this electric power to the mainland electric transmission system via two 115 kV alternating current (AC) submarine cable circuits to the selected landfall site at New Hampshire Avenue in Yarmouth, Massachusetts. The upland cable system installed underground within existing rights of way (ROWs) and roadways in the Town of Yarmouth and NSTAR Electric ROW, where it will interconnect with the existing NSTAR Electric Barnstable Switching Station.

The transition of the interconnecting 115 kV submarine transmission lines from water to land will be accomplished through the use of Horizontal Directional Drill (HDD) methodology in order to minimize disturbance within the intertidal zone and near shore area. HDD would be staged at the upland landfall area and involve the drilling of four boreholes from land toward the offshore exit point, approximately 100 feet offshore. Conduits would then be installed the length of the boreholes and the transmission lines would be pulled through the conduits from the seaward end toward the land. A below grade landfall transition vault will be installed in New Hampshire Avenue using conventional excavation equipment (backhoe) at the upland transition point where the submarine and land transmission lines would be connected. The energy produced by the Wind Park will be transmitted by this cable system to the electric transmission system serving Cape Cod, the Islands of Nantucket and Martha's Vineyard ("the Islands"), and the New England region.

The turbines will be approximately 4.7 miles (7.6 km) or more from the Cape Cod shoreline. Each turbine will be mounted on a monopile at about 246 feet (75 m) above sea level (asl). A pre-fabricated access platform and service vessel landing will be located around each monopile at about 30-35 feet (9-11 m) from MLLW Each of the three turbine rotor blades will be 170 feet (52 m) in length and the rotor-swept area will extend from 75 - 417 feet (23 to 127 m) above MLLW, with each WTG having a rotor-swept area 90,800 square feet (8,500 $m^{2)}$.Turbines will be installed on a grid of about 0.54 x 0.34 nautical mile (1.0 x 0.63 km), with connecting inner-array cables buried beneath the seafloor to an approximate depth of 6 feet (1.8 m). The turbines will rotate at 8.5 to 15.3 revolutions per minute (rpm) and will shut down at wind speeds above approximately 55 mph (25 m/sec). The ESP will be approximately 200 feet long by 100 feet wide, with an overall height of approximately 100 feet above MLLW (61 m x 30m x 30m) and located near the center of the WTG array. It will house transformers and cables, as well as having a boat landing and heliport. The lighting of the WTGs and ESP is discussed below (Section 5.0). For more information about design and construction of the WTGs and ESP, see Section 4.0 of the DEIS-DEIR document.

Construction and operation of the proposed Project will not preclude or prohibit traditional uses of the water-sheet area within or around the turbine array. Use of the water sheet area within the turbine array would include general commercial and recreational navigation, commercial and recreational aviation, commercial and recreational fishing, and other traditional water-based activities that promote the use and enjoyment of this area of Nantucket Sound.

2.2 Alternatives to the Proposed Action

The Applicant has analyzed alternative technologies and site locations for the Project (see Section 3.0 of the DEIS-DEIR), considering both terrestrial and offshore locations throughout New England. The alternative analysis determined that Nantucket Sound is the only technically and economically feasible location for installation of an offshore wind park based on the application of preliminary screening criteria. Additional siting analysis was then conducted to evaluate specific locations within the Sound. Nantucket Sound alternative sites (Figure 1) include Horseshoe Shoal (Site 1 – the Proposed Alternative Site), eastern Nantucket Sound near the Monomoy Island area (Site 2 – named Monomoy-Handkerchief Shoal), and southern Nantucket Sound near the Hawes and Tuckernuck Shoals area (Site 3 – named Tuckernuck Shoal).

2.3 Affected Environment

This section describes the physical and biological characteristics in Nantucket Sound in general and in the proposed Alternative Site and other alternative sites in Nantucket Sound when possible. Additional information on these topics is available in Section 5.0 of the DEIS/DEIR/DRI prepared by the USACE pursuant to the National Environmental Policy Act (NEPA).

2.3.1 Physical Environment

This section is based on published information and studies by the Applicant and provides a basis for understanding the oceanographic processes that affect the Common Tern in Nantucket Sound.

Hydrography: In general, the bathymetry in Nantucket Sound is irregular, with a large number of shoals present in various locations throughout the glacially formed basin. Charted water depths in the Sound range between 0 and 70 feet (0 and 21 m) at MLLW. The shoals have complex shapes. The Proposed Alternative Site (Site 1) is located on Horseshoe Shoal, a prominent geological feature in the center of the Sound with water depths as shallow as 0.5 feet (0.15 m) at MLLW. Site 2 is located in the eastern part of Nantucket Sound west of Monomoy Island and is named Monomoy-Handkerchief Shoal. It has extensive areas of shallow water averaging 6 to 8 feet (1.8 to 2.4 m) deep. Site 3 is located on Tuckernuck Shoal, in the southern portion of Nantucket Sound, northwest of Nantucket and

Muskeget Islands and east of the opening between Nantucket and Martha's Vineyard. Localized areas on the crest of Tuckernuck Shoal are as shallow as 2 feet (0.6 m).

Water depths between Horseshoe Shoal and the Cape Cod shoreline are variable, with an average depth of approximately 15 to 20 feet (4.6 to 6.0 m) at MLLW. Along the submarine cable system route, depths vary from about 16 to 40 feet (4.9 to 12.2 m) at MLLW, with an average depth of approximately 30 feet (9 m) at MLLW. Water depths in Lewis Bay and Hyannis Harbor are variable ranging from eight to 14 feet (2.4 to 4.3 m) at MLLW in the center of the bay to less than five feet (1.5 m) at MLLW along the perimeter and between Dunbar Point and Great Island. Water depths along this route in Lewis Bay range from five to 15 feet (1.5 to 4.6 m), with an average of ten feet (3 m). The shallowest portions of Lewis Bay/Hyannis Harbor along this route exist between Great Island and Dunbar Point, with depths of one to four feet (0.3 to 1.2 m) at MLLW.

Currents: The water 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. Typical tidal heights are in the range of one to four feet (0.3 to 1.2 m); times of high and low tides differ throughout the Sound by up to two hours.

Tidal flow and circulation within the Sound generate complex currents, generally flowing to the east during the flood tide (incoming) and to the west during the ebb tide (outgoing). Peak tidal currents often exceed two knots and 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 2152 ft^2 (200 m^2) per tidal cycle; roughly 5% of the total easterly and westerly tidal flows (Bumpus et al. 1971).

Mean tidal current velocities were calculated to be approximately 2 feet/second at Horseshoe Shoal; less than 2 feet/second at Tuckernuck Shoal, and more than 2.5 feet/second at Monomoy-Handkerchief Shoal. Wind-driven current velocities modeled at Horseshoe Shoal were found to be much lower than tidal velocities and concentrated over the crest of the shoal (Appendix 5.2-A of the DEIS-DEIR).

Sediment Distribution: Nantucket Sound generally contains sand- and silt-sized surficial marine sediments, with localized patches of clay, gravel and/or cobbles. Small areas of glacially deposited rocks and boulders near the northern shore of the Sound are continuously subaerially exposed , or exposed at low tide, and shifting sandbars covered only by storm tides are characteristic of the area near Muskeget Island, but no such exposures occur in the alternate sites for the turbines. Subtidal boulders are widespread near the northern shore off the entrance of to Hyannis Harbor but are rare in the three alternative areas for the turbines. Some areas of subtidal cobbles are uncovered seasonally by movements of sand. Shifting sandbars are subaerially exposed to varying extents in the southern parts of the Sound, near Muskeget Island. One such transient exposure is shown on Figure 1 with the informal name "Fernando's Fetch": it was present throughout the period of the surveys reported here and was used by birds and seals. The sediments were derived from material originally transported from upland areas during glacial and post-glacial periods, and are now continually sorted and reworked by tidal, current, wave and storm actions. Shallow marine sediments were collected in vibracores and benthic grabs during 2001 and 2002 across the Proposed and alternative sites. Visual analysis of sediments within the 0- to 2-foot (0 to .6 m) depth range beneath the seabed indicates the presence of fine- to coarse-grained sands in areas of relatively shallow bathymetry, with fine to silty sands and silts predominating in deeper surrounding waters across the three sites. This distribution is consistent with the higher-energy marine environments typically found in shallower waters, where finer sediments are winnowed away by current and wave action. The fines then settle out and deposit in the surrounding lower-energy deeper water areas.

Medium-grained sands predominate atop the U-shaped Horseshoe Shoal, with fine-grained sands found in the east-opening embayment. Localized fractions of silt, gravel and/or cobbles, consistent with glacial drift may also be present in the area. Fine to silty sands were encountered in the deeper water portions surrounding the shoal area. Fine sands predominate in the western and central portions of Monomoy-Handkerchief Shoal, with silty sands to the east in deeper waters. Across Tuckernuck Shoal, fine sands predominate, with an area of medium to coarse sands traversing the center of the shoal and oriented parallel to the tidal currents sweeping between Martha's Vineyard and Nantucket. Silty sands were encountered to the east of Tuckernuck Shoal, again in the deeper water areas surrounding the shoal.

A geophysical survey across Horseshoe Shoal conducted in 2001 identified areas of sand waves, especially in the south central portion of the shoal. The sand wave crests were oriented generally in a north-south direction, with long period wavelengths ranging between 100 to 600 feet (30 to 183 m). Short period sand waves are located between the larger crests. The average sand wave height was 4 to 5 feet (1.2 to 1.5 m), but waves as high as 15 feet (4.8 m) were found. The size of the sand waves attest to the dynamic shallow water environment on Horseshoe Shoal. The symmetry of the sand waves indicates migration to the east or west, depending on where they formed on the shoal. In other areas of the shoal, the majority of the seafloor contained few significant features and smooth sandy bottoms (Ocean Surveys, Inc., July 2002).

Sand waves were also identified within the Tuckernuck Shoal area (as well as across Horseshoe Shoal) during a geophysical survey of subsurface conditions in Nantucket Sound conducted by USGS in 1976 and 1977. Sand waves were not identified by USGS across what is now the Monomoy-Handkerchief Shoal alternative site during that survey (O'Hara and Oldale, 1987). The geophysical survey conducted by Cape Wind in 2001 did not cover the Tuckernuck or Monomoy-Hankerchief Shoal alternative site areas.

Along the submarine cable system route, seabed sediments contain fine to coarse size sands, with patches of clay, silt, gravel and/or cobbles. Intermittent glacially transported boulders may also be present along the route, especially off the entrance to Hyannis Harbor.

Sediment Quality: Bulk chemical analyses were performed on selected core samples obtained from the WTG array area and along the proposed submarine cable route into Lewis Bay to determine whether the sediments could pose an environmental concern. To assess the relative environmental quality of these sediments, the laboratory results for the chemical analyses were compared to sediment guidelines typically used by agencies to evaluate risk from contaminants in marine and estuarine sediments (NOAA Effects Range-Low (ER-L) and Effects Range-Median (ER-M) guidelines). None of the targeted chemical constituents were detected in the samples above ER-L or ER-M guidelines (Long et al., 1995) for marine sediments. The ER-L and ER-M guidelines use numerous modeling, laboratory, and field studies to establish values for evaluating marine and estuarine sediments. Concentrations below the ER-L represent a concentration range in which adverse effects are rarely observed. Section 5.1 of the DEIS-DEIR has more detailed information on sediment quality in the Project Area.

Sediment Transport: Analytical Modeling conducted for the Project (see Appendix 5.2-A) found that active sediment transport occurs at all of the shoals, even under typical wave and tidal current conditions. The highest sediment transport rates are focused locally on the shallowest portions of the shoals, and there is relatively little sediment transport in the deeper regions for typical conditions. The most dynamic transport conditions are shown to be on Monomoy-Handkerchief Shoal. This shoal is due east of and does not fall within Alternative 2. This is expected due to the extensive shallow flats in this area, relatively swift tidal currents that funnel at this location between the Sound and Ocean, open western exposure to waves generated within the Sound, and relatively fine sediment grain size at this location. Although Tuckernuck Shoal experiences the lowest tidal currents, the potential sediment transport rate for typical conditions is on the order of Horseshoe Shoal due to the fine grain size of sediments at Tuckernuck Shoal. Seasonal variations in sediment movements on the shallowest shoals result in changes in the surficial layers. Additional information is summarized in Section 5.2 of the DEIS-DEIR.

2.3.2 Biological Environment

This section provides a basis for understanding the biological and ecological conditions within the proposed Project Area that contribute to the habitats for the listed species.

Submerged Aquatic Vegetation: Submerged aquatic vegetation (SAV) including seagrass beds provide habitat for many species of benthic invertebrates and fish and so may be important foraging areas for terns. The MADEP Wetlands Conservancy Program has mapped SAV beds one quarter acre or larger in size along the coastline using aerial photography, GPS, and a digital base map. Mapping was completed in 1995 and 2000; the 1995 data is available from MassGIS. One SAV bed has been mapped within Lewis Bay, located to the west of Egg Island in the Town of Barnstable. A December 2002 telephone conversation with Mr. Charles Costello of the MADEP Wetlands Conservancy Program indicates that the mapped SAV bed has not changed much in size between 1995 and 2000. In addition to the mapped SAV in Lewis Bay, MADEP has mapped areas of SAV in Hyannis Harbor in the Town of Barnstable and to the west of Great Island in the Town of Yarmouth. Field investigations have been conducted to determine the extent of mapped SAV beds in the vicinity of the proposed project. The submarine cable system will be no closer than 70 feet (21 m) from the edge of the eelgrass bed located near Egg Island.

Plankton Communities: Plankton refers to those plants (phytoplankton) and animals (zooplankton) that cannot maintain their distribution against the movement of water masses. Individual plankters are generally very small or microscopic; however, organisms such as jellyfish are often considered with the plankton community. Review of the scientific literature suggests that little information exists describing the plankton communities of Nantucket Sound. However, because all coastal and offshore waters contain both phytoplankton and zooplankton communities, it is expected that the waters within Nantucket Sound also support a diverse and abundant plankton community. Plankton abundance and distribution is of particular interest since, in the case of phytoplankton, they form the base of the marine food web. Larger zooplankters, including crustaceans and larval stages of many fish are taken by terns. Phytoplankton dynamics in all waterbodies, including those of Nantucket Sound are controlled by a suite of variables including light, temperature, nutrients, grazing by higher trophic level organisms and species interactions. These planktonic communities are generally variable in time and space resulting in relatively patchy distributions. The turbulence resulting from tidal currents over the shoals results in extensive mixing of the surface layers of the Sound, facilitating harvest of planktonic organisms by other trophic levels, including terns.

Benthic Communities: The benthic fauna is of crucial importance to bottom-feeding bird species, notably the wintering seaducks, but its composition is not directly important to the surface feeding terns. A detailed summary of information from an extensive review of the literature and from surveys conducted in 2001 and 2002 is available in Section 5.3 and Appendices 5.3-A and 5.3-B of the DEIS-DEIR.

Finfish: The waters of Nantucket Sound support a diverse fish community. Many of the fish found within the region are local inhabitants that remain year-round, while other species are migratory and move into and out of the Sound in response to temperature changes. Small fish serve as the most important prey for the Common Tern.

The migration patterns and seasonal presence of the fish that are prey of terns influence the areas where terns forage. The seasonal presence of bluefish, striped bass, and other large predatory fish is also very important for surface-feeding terns because these predators drive small baitfish to the surface where the terns can catch them. In New England, terns feed extensively on sand lance (*Ammodytes*), and on other fish such as herrings (*Clupea* *harengus, Alosa aestivalis*), mackerel (*Scomber scombrus*), anchovies (*Anchoa* spp) and silversides (*Menidia menidia*), depending on their availability. All of these species have been observed in Nantucket Sound during some time of the year (see Section 5.4 of the DEIS).

Sand lance or sand eels (*Ammodytes*) occur in estuarine, open coastal, and offshore habitats, generally over sandy substrates. They are habitat dependant and are typically found in areas with high bottom current velocities over sandy substrates. Juveniles and adults are generally found in schools during the day with larger schools found in deep waters, and smaller schools found over shoal habitat (Auster and Stewart, 1986). No specific data on the abundance and distribution of sand lance in Nantucket Sound was found, but the habitat characteristics of Nantucket Sound indicate that sand lance are likely present in the Project Area.

Herring (*Clupea harengus*) form large schools in coastal waters throughout the Gulf of Maine and off southern New England (Reid et al. 1999). In the summer and fall, juveniles move from nearshore waters to overwinter in deep bays or near bottom in offshore areas (Reid et al. 1999). Some juveniles spend at least the spring and early summer off southern New England, especially off southern Massachusetts (through at least mid-June) before moving into the Gulf of Maine or offshore, presumably east of Cape Cod (Reid et al. 1999). According to the Massachusetts inshore trawl surveys (1978-1996), as reported by Reid et al. (1999), juveniles in spring were most abundant northwest of Cape Ann, throughout Cape Cod Bay, along the northern shore of Nantucket Island and southern shore of Martha's Vineyard, and Buzzard's Bay. Juveniles were also found to a lesser degree in the northeast corner of Nantucket Sound near Monomoy Island and off the south shore of Dennis, MA. In the fall, the largest catches of juveniles occurred around Cape Ann, in central and western Cape Cod Bay, off Buzzard's Bay, and off the southern shore of Martha's Vineyard. Therefore, herring are found in Nantucket Sound, but data indicate that they seem to be more prevalent on the outer reaches of the Sound, outside of the Project Area.

Mackerel (*Scomber scombrus*) have the same geographic distribution as herring, but the migration patterns differ. Juveniles are common in Nantucket Sound from August to November and adults in March, April, and October to December as indicated by the Estuarine Living Marine Resources (ELMR) Program database provided by NOAA. Occurrences of juvenile Atlantic mackerel were highest in the fall and occurrence of adults were highest in the spring (Studholme et al. 1999). Yet, based on a Massachusetts coastal zone survey in Studholme et al. (1999), juvenile and adult mackerel in Nantucket Sound occur only randomly. Silversides (*Menidia menidia*) are highly abundant in the shore-zone of salt marshes, estuaries and tidal creeks. Juveniles and adults prefer habitats over vegetated substrates compared to habitats of sand and gravel (Fay et al., 1983). Silversides spawn in the intertidal zone of estuaries and tributaries (Fay et al., 1983) and therefore are more likely to occur in the nearshore areas of Nantucket Sound and not within the WTG array. Terns have been observed to feed on spawning schools of silversides. This foraging behavior in Nantucket Sound is therefore likely to occur in nearshore areas, outside of the WTG array.

Section 5.4 of the DEIS-DEIR has more detailed information on finfish in Nantucket Sound from surveys by MDMF. The USACE directed that this BA should use fisheries data available from appropriate agencies.

3.0 MASSACHUSETTS SPECIES OF SPECIAL CONCERN

This section examines the natural history of the Massachusetts listed species of special concern, the Common Tern. The state and federally listed threatened Piping Plover and the endangered Roseate Tern are addressed specifically for the NEPA submission in Appendix 5.7-H. Both Roseate and Common terns forage in the waters of Nantucket Sound and travel throughout the general Project Area during the summer (late April – late September).

3.1 Common Tern

The Common Tern (*Sterna hirundo*) is a medium-sized tern weighing about 4.2 oz (120 g), with a wingspan of 30 inches (75 cm); in the breeding season it is generally pale gray with a black cap and black-tipped orange bill. The Common Tern has a wide global distribution, nesting through much of the northern hemisphere in both marine and freshwater locations, and wintering along tropical and subtropical coasts. In the northwestern Atlantic, Common Terns are the most numerous species of tern and their colonies often include other tern species, including Roseate Terns. In the Project Area, the two species often feed, roost, and probably migrate in mixed flocks. Common and Roseates are similar in appearance so that characterization of Common numbers and activities is sometimes difficult and some conclusions have to be drawn from observations that do not differentiate the two species. The principal source for the natural history information presented here is the recent comprehensive species account in “The Birds of North America” (Nisbet 2002).

3.1.1 Population Status and Trends

In North America, the Common Tern is the most widespread and familiar tern (total numbers on the order of 150,000 breeding pairs). It breeds at inland locations from southern Northwest Territories and northern Montana eastwards to the Great Lakes and the Atlantic coast. Maritime breeders extend from Labrador to South Carolina and there are small isolated populations in Bermuda and the Caribbean. Some exchange of breeding birds occurs between the Great Lakes and the Atlantic coast. Wintering birds occur principally along South American coasts with smaller numbers on the Pacific coast of Central America and in the Gulf of Mexico. There have been no marked changes of breeding distribution since historical records started, in about 1870, but major fluctuations in numbers have occurred. The population along the Atlantic coast was almost eliminated in the late 19th century, principally by slaughter for the millinery trade, but recovered speedily through the actions of Audubon societies and other conservation initiatives. Numbers peaked in the 1930’s with about 45,000 pairs in New England and 7,000 pairs in New York (Long Island), but numbers were probably lower than the historical highs. Subsequent numbers declined as expanding gull populations took over the best nesting sites and toxic chemicals reduced breeding success. At the low point, in the mid-1970’s, there were about 9,000 pairs in New England and 11,000 pairs in New York. Since then, numbers have increased to about 20,000 pairs in New England and 18,000 pairs in New York in the 1990’s. In recent years, the numbers in some areas have stabilized but continued to increase slowly in Massachusetts. In 2001, 14,378 pairs were reported in the Commonwealth, an increase of 2% from 1999 (Blodget 2001). This favorable picture depends upon extensive active management. Twelve former tern colonies, from Maine to Long Island, NY, have been restored by removal of gulls that had usurped the sites. Common Terns have recolonized all these sites and Roseates appear to be established at three of these sites. One site in Buzzards Bay, Massachusetts has been restored successfully and is now used by both Roseate and Common Terns (Ram Island, Mattapoisett). A second restored site, Penikese Island, also in Buzzards Bay is now (2002) used by small numbers of Common Terns. In 2003 overall numbers were similar, but additional birds shifted to Penikese Island in association with the hazing at Ram Island that followed the Bouchard 120 oilspill and the presence of predators on Bird Island. Restoration efforts (1999 - 2003) on Muskeget Island, the site of a very large tern colony in the late 19th century, have met with only limited success (I. Nisbet, pers. comm.).

3.1.2 Seasonal Occurrence

The first Common Terns typically arrive in Nantucket Sound in mid-April and most have left by the end of September, with a few lingering occasionally as late as December or even January. In general they arrive earlier and stay later than the Roseates, and are more widely distributed. In addition to those nesting nearby many may pass Nantucket Sound in spring and fall and may pause there during the course of their annual travels but the extent of such “staging” is not well known: it is conspicuous in fall but less marked in spring

In the vicinity of Nantucket Sound, the Common Tern is a locally abundant breeder. Most occur in 3 large colonies. The following numbers are for year 2002: on Monomoy, nearly 8,000 pairs; and in Buzzards Bay, nearly 4,000 pairs in 2 colonies. A further 2,000 pairs were distributed among 13 small colonies in the region. Numbers in colonies fluctuate, e.g. an important site in Plymouth, MA was largely abandoned in 1999, and those birds probably contributed to a large increase in numbers breeding at Monomoy. Additional terns visit the region before and after the breeding season, particularly in late summer, when South Beach, Chatham is the principal pre-migratory staging area for very large numbers of both Common and Roseate Terns, which also occur at several sites along the southern edge of Nantucket Sound (Veit and Petersen 1993).

Courtship activities are conspicuous early in the season, both before and after arrival at the colonies and include both displays on the ground and spectacular courtship flights. During such flights, the terns spiral steeply upward, sometimes to heights of approximately 300 feet (100 m) or more. From their colonies, the terns travel on several flights each day, sometimes to distant feeding grounds (over 30 miles (48 km)) and carry fish back for their mates and young. Early in the season (May) unmated birds and pairs in the early stages of breeding may spend much of the day near distant feeding areas.

The Common Tern usually lays 1-3 eggs between mid-May and mid-June which are incubated by both sexes. The eggs hatch after approximately 22 days and young fledge approximately 23 days after hatching. However, the young birds remain dependent on their parents for approximately 8 weeks after fledging. Adults may relay if they lose eggs but generally raise no more than one brood of chicks.

After the breeding season, both Roseate and Common Terns disperse from the colonies to feeding areas around Cape Cod and the Islands. By mid August many gather at large roosts on South Beach, Chatham, and at other locations near the Sound including Eel Point and Smith Point on Nantucket, and on Tuckernuck Island, see Figure 1, (Trull et al., 1999) and some may remain in Buzzards Bay. At these staging areas the Roseate and Common terns are joined by birds from other parts of New England. During late summer, Roseate and Common terns are more difficult to distinguish than earlier in the year. The Roseates molt their long outer tail feathers immediately after nesting and their bill-color changes from all black (in May) to orange with black tip: in both respects they are more like Commons. In addition, Roseates are much more vocal than Commons, so that species-characteristic calls are unreliable for establishing numbers in mixed flocks.

Migratory movements are not known in detail. Commons migrate in flocks, probably with Roseates, and are thought to fly directly from staging areas, such as Monomoy or Nantucket Island, to the Caribbean or South America, most departing in September (there are few records of migrants from intervening coasts.). Altitude of migration has not been measured but large flocks (sometimes thousands of terns) departing staging areas on Cape Cod in the fall, heading seawards, climbed rapidly to heights at which they would usually pass unseen, likely >650 feet (200 m) (Veit and Petersen, 1993; S. Perkins, pers. comm., 2002). Common and Arctic Terns (*S. paradisaea*) migrating in fall, tracked by radar across southern Sweden, climbed rapidly to altitudes of approximately 3000-10,000 feet (1,000-3,000 m) while some migrants flew close to the surface along the coast when facing contrary winds (Alerstam, 1985). Flight altitudes of coastal migrant terns (all<25 m) have been reported by Kruger and Garthe (2001), see below. Spring arrivals in Massachusetts have not been described in sufficient detail to include altitudes of incoming birds.

As described below, Commons more often feed along diverse types of shorelines (rocky and sandy beaches, bays, salt marshes) than do Roseates but readily feed offshore, at shoals or over prey driven to the surface by predatory fish, and occur throughout Nantucket Sound. The results of recent surveys in Nantucket Sound are summarized in the Roseate account (in Appendix 5.7-H) which combines observations of both species in the section on "Use of Nantucket Sound".

3.1.3 Food and Feeding Habitats

Common Terns have a more diverse diet than Roseates. It varies from place to place, year-to-year, and hour-to-hour depending on food availability. Small fish predominate their diet in biomass but invertebrates such as crustaceans, squids, insects, and other taxa are often more numerous (Nisbet 2002). Many prey are captured from the top half-meter of the water by plunge-diving from heights up to 20ft (6m), generally lower than Roseates. Foraging terns, apparently intent on the water below and recognizable by their downward-pointing bills, fly <40 ft (12 m) from the water surface. Prey are also taken by surface dipping; food items acquired in this way include those made available in a ship's wake as well as many insects trapped in the surface layer. Some insects, however, are captured in the air. Common Terns (and several gull species, but not Roseate Terns) have been reported occasionally hawking for flying ants (and other Hymenoptera) up to heights of 200 feet (60m) or more (Nisbet 2002). This behavior may occur whenever alates (winged reproductives) emerge and is probably most frequent in late summer but has not been examined quantitatively. Swarms of these flying prey may enter rising thermals and drift long distances downwind. Terns observed circling together in thermals ("kettling") may be catching such prey.

Common Terns not only consume a wider variety of prey than Roseates, they also forage in a much wider range of microhabitats. These habitats include not only along diverse types of shorelines, where individuals will, upon occasion, defend feeding territories, but also shallow waters, sandbars, and offshore areas. Movement of water across steeply-shelving subsurface topography is thought to be one major factor that brings small fish within reach of surface-feeding terns. Common Terns visit harbors and anchorages, where they may use docks, channel markers, and moored vessels as bases for feeding territories. Some individuals will use a navigation buoy far from shore in a similar manner but most offshore foragers travel independently and readily join flocks wherever prey become available. Please refer to Section 3.1.6 below for more information on use of Nantucket Sound by Common Terns.

3.1.4 Flight Behavior

Four categories of flight can be recognized in the context of potential risks from wind turbines. When foraging, Common Terns fly below about 40 feet (12 m) asl, often <16 feet (5 m), however some foragers fly high in pursuit of insects, as described above, and could occasionally enter the rotor swept area.

When traveling to a distant feeding site, roost, or colony, and when migrating near the shore, height is strongly affected by the wind direction: near wavetops when flying into the wind, higher if downwind. A study of coastal migrants in the North Sea (Kruger and Garthe 2001) showed strong effects of wind direction on altitude of flight. Flying birds were placed into four height zones. However, even in following winds, none of the terns were seen in the highest zone, >25meters. This study reported on 271 Common/Arctic Terns (the two species are difficult to distinguish) and 959 Sandwich Terns. Another study in the North Sea reported on visual observations of migrating birds within about 300 m of the sea surface made from the island of Heligoland, in which the flight altitudes were summarized as above or below 50m (Dierschke and Daniels 2003, as cited by ICES 2003). For 18464 terns (of 5 species) only 241 (1.3%) were flying above 50 m.

When flying over land, Commons (and other terns) fly much higher: to approximately 300 feet (100 m) or more when commuting. During migration over land terns travel at >1000 m (see above).

During courtship, which sometimes occurs before reaching the nesting areas in the spring, Common Terns may fly to approximately 300 feet (100 m, see above). Recent observations of flight behavior in Nantucket Sound are summarized in Section 3.1.6 below.

3.1.5 Known Mortality and Disturbance Factors

Most mortality of Common Terns appears to occur during migration or in the wintering areas and is almost unknown. Occasional instances of predation in colonies are reported. Annual survival of adults has been estimated as about 0.90 (several estimates have been made, some using rigorous mark-recapture methodology). Estimates of survival probability to first breeding (at age 3 or 4 years) are approximately 0.1 but vary widely in methodology and results. During the breeding season, some adult mortality from predation has been documented, and displacement by gulls has been an important factor. Toxic chemicals, including organochlorines, have been well-studied in this species. Reproductive failures induced by DDE probably contributed to major population declines in the late 1950s and 1960s, but no important threats are currently recognized. Mortalities from entanglements with monofilament fishing line and collisions with automobiles have been occasionally noted but not recognized to be important.

Disturbance of nesting colonies (by people, dogs, aircraft, etc.) can cause abandonment and resultant losses, but most colonies are now carefully managed. Terns in foraging areas appear to be relatively insensitive to boat traffic. Common Terns have nested successfully in an empty barge immediately adjacent to shipping lanes in the New York/New Jersey Harbor off Jersey City, New Jersey (pers. obs. P. Kerlinger). Sport fishermen commonly use tern flocks to locate their preferred targets: the predatory fish driving baitfish to the surface. When approached by such boats, tern flocks often move or disperse because the predatory fish move.

3.1.6 Use of Nantucket Sound

Both Common and Roseate Terns have long been known to forage extensively in Nantucket Sound. Recent work has documented the locations, numbers, and behavior of terns more completely, focusing principally on occurrences in and near the project area. Six studies of terns are summarized here, including data from five years, these data refer principally to terns traveling or foraging in the area: 1) A boat-based survey in 1990-1991, principally concerned with Roseates from Bird Island, reported to USFWS (Heinemann, 1992); 2) a preliminary study in 2001, comprising six aerial surveys sponsored by Cape Wind; 3) systematic aerial surveys in 2002 and 2003, plus boat surveys, also funded by Cape Wind; and 4) similar flights and boat surveys in late summer 2002 and summer 2003 by Massachusetts Audubon Society (MAS), funded through Massachusetts Technology

Collaborative. (The MAS studies are continuing in 2004) This summary also incorporates data from other sources. Common Terns were reported in larger numbers than Roseates in all the surveys. In the area surrounding Nantucket Sound (Figure 1) about 14,000 pairs nest, compared to about 1,500 pairs of Roseates.

3.1.6.1 Distribution of Terns in Nantucket Sound

Observations of Roseate Terns from the breeding colony on Bird Island foraging in western parts of Nantucket Sound (Heineman, 1992) were notable because until then the distances traveled by foragers were unknown. At that time virtually all Roseates nested on Bird Island but Common Terns were much more widely distributed so that the places of origin for those foraging in the Sound were not evident. Some individuals have been observed flying from the Sound towards the colonies in Buzzards Bay and many travel from the large colony on Monomoy.

Six aerial surveys in summer 2001 showed that during the period of chick-feeding (June to mid-July) terns used Horseshoe Shoal less frequently than the shoals to the west, and during the period of pre-migratory staging, when terns gather at South Beach, Chatham, there were more terns to the east of Horseshoe Shoal. These findings suggested that only small numbers of terns used the area or commuted through it (Hatch 2001).

In the summer of 2002, Cape Wind funded systematic surveys of birds using the open waters of Nantucket Sound that are reported in Appendix 5.7 F. Terns were recorded on all six aerial surveys along transects of a large study area in the center of the Sound from May 22 to August 30, 2002. These transects were 1300 ft (400 m) in width and covered 19% of the area. Terns were also seen during the seven boat surveys, May - August 2002. Common and Roseate Terns were seen widely in the Sound, but were more abundant near shore and outside of the study area. A total of 1,764 terns were observed in the study area, of which 1,014 were Common and 570 were Common/Roseate type. Densities over Horseshoe Shoal were relatively low: 4.8 individuals/sq.km. The numbers of terns seen over Horseshoe Shoal varied from 0 to 52 birds per survey, being high in May and again in mid-August (one survey). Terns were observed singly and in flocks numbering up to 201 (mean = 5). Daytime loafing areas, before and after the breeding season, included the jetties at the mouth of Waquoit Bay (north of the proposed wind farm) and the exposed sandbar northwest of Muskeget Island ("Fernando's Fetch") that is south of the proposed Wind Park.

Also in 2002, Mass Audubon conducted 11 aerial surveys of Nantucket Sound from August 19 to September 19 to ascertain abundance and distribution of Roseate and Common Terns during the pre-migratory period (Perkins et al., 2003). Their findings were very similar to those of the Applicant's surveys. The terns were much less abundant over Horseshoe Shoal and other central ("offshore") parts of the Sound than near the northern and especially the eastern edges of the Sound. During the 11 flights, the observers recorded 5,721 terns in transects of width approximately 7,000 feet (2,133 m) (to limits of visibility), which included 634 Roseate, 1,767 Common, 3,311 Common-Roseate type and 9 Least Terns. The methods used by Mass Audubon were suited to counting but not measuring bird densities.

In 2003, 20 aerial surveys for Cape Wind were conducted from March to December, principally examining the same study area as in 2002: these are reported in Appendices 5.7-F, 5.7-K, 5.7-L, 5.7-M. Terns were seen on every survey from April 18 to November 19 (Roseates from May 12 to September 15). Larger numbers were present on Horseshoe Shoal in May, fewer thereafter. The year 2003 was unusual in that exceptionally large numbers of terns were present in Buzzards Bay after the breeding season (J.J.Hatch, personal obs.)

Terns were observed in 2002 and 2003 during the aerial surveys from April to November (principally May to September). To evaluate their use of the study area the results of all surveys were summed. The combined results of the standardized aerial surveys in 2002 and 2003 are presented in Figure 5.7-13 in Section 5.7 of the DEIS – DEIR to show the seasonal pattern of numbers in the Study Area and over Horseshoe Shoal. These combined surveys of the study area showed that <10% of the terns (277/2,888) recorded during the aerial surveys were observed over Horseshoe Shoal, which comprises 13% of the study area. Expressed as cumulative number/area there were 13.1 terns/km^2 over Horseshoe Shoal and 17.1/km^2 in the whole study area. Additional observations indicate that terns were much more numerous near the shore than in the study area (Appendices 5.7-F, 5.7-K, 5.7-L, 5.7-M). As noted previously, many terns could not be identified to species and were recorded as "Common/Roseate": this difficulty was especially apparent in mixed flocks. These results indicate that Horseshoe Shoal is not an exceptional area in Nantucket Sound for terns.

Also in 2003, May 15– July 31, Mass Audubon examined tern activity during 13 boat surveys on Horseshoe Shoal and in three aerial surveys of a large study area in the Sound using narrow transects. These surveys showed similar temporal and spatial patterns to those reported by the Applicant.

In summary, these surveys, which were all conducted during conditions of good visibility, reported low numbers of Common Terns over Horseshoe Shoal compared to other parts of Nantucket Sound

3.1.6.2 Tern Behavior and Altitude of Flight in Nantucket Sound

The following paragraphs include not only observations from the studies mentioned above, but also various additional records that shed some light on the tendency of terns to fly at altitudes where they might be at risk of collision with turbine rotors (75 – 417 feet (23 – 127 m)). It is difficult, of course, to record heights above the sea surface precisely; however, this does not seem to be a major problem because so few terns were observed to be close to the height of the rotors (see below), that increases in precision would have negligible effects. Although the Roseate and Common Terns tend to dive from different heights (Roseate higher with a maximum of 40 feet (12 m)), neither tern approaches rotor height while seeking aquatic prey. Because the two species are not known to commute at different heights and in many cases, the terns were not identified to species, the following discussion will group the observations for these two species.

Almost all flying terns observed from boat or ground were below 60 feet (20 m) asl. Those flying below 40 ft (12 m) included both foraging and traveling individuals. In 2002, of 1,585 estimates (excluding 190 Least Terns, all flying below 50 ft) 18 (1.1%) were at 60 - 80 feet and 30 at 110 feet (several loose flocks passing Cape Poge on September 13.). These were identified as Common Terns. In addition, during only one of the 17 aerial surveys (combining Cape Wind and Mass Audubon aerial surveys), on August 28, several flocks were seen by Mass Audubon observers in the eastern third of the Sound at altitudes up to about 500 feet (150 m). On this occasion the only terns identified to species were Commons and they appeared to be flying in thermals and no explanation was apparent (Perkins et al., 2003). Foraging Common Terns, occasionally pursue insects in thermals and could be drifted offshore by day while doing so.

In 2003, altitude estimates from the boat totaled 2,251 individuals, of which only 3 were above 60 feet. Also during 2003, MAS estimated heights of 222 flying terns from a boat: 8 (3.6%) were above 60 feet (6% if foragers excluded). For all these observations, Common Terns were most often identified and there were large numbers of “Common/Roseate” types, and identified Roseates were in a minority. During boat surveys (by Cape Wind and by Mass Audubon), which are better suited for recording altitudes, all flying terns observed were well below rotor height. During Cape Wind boat surveys, 34 observations were made of flying Roseates (197 individuals) and 113 of flying Commons (698 individuals) and Mixed terns (1,380 individuals). Almost all of these were observed flying at or below 33 feet (10 m) asl. Only three were above that height, and they flew no higher than 66 feet (20 m). Flocks of foragers numbered from 1 to 33 individuals. During August 2002, Mass Audubon observers during two boat surveys, made six observations of 42 terns (one definitely identified as Roseate) and they were all below 50 feet (15 m) asl.

Several land-based observations (by J. J. Hatch) indicate that both species may fly higher than 100 ft (30 m) when over land, these included commuting birds, those returning to colony or roost.. Terns, some carrying fish, have been seen over Falmouth on several occasions, evidently returning towards Bird Island from Nantucket Sound, flying well above 100 ft (30 m). At dusk in late August 2001, individuals of both species approached the roost on South Beach, Chatham from the north (over the beach) flying at about 120 feet (37 m, estimated from below). On September 17, 2002, similar flights over South Beach were measured at 200 feet (60 m), with a clinometer at known range.

On the other hand, observations of commuters at sea showed no differences in altitude from daytime travelers in the area. The altitude of all terns measured within 30 minutes of sunrise or sunset, when most individuals are traveling towards or away from their overnight roost, was within 30 feet (10 m) of the water surface.

On August 1 and 15, 2002, numerous individuals of both species were observed flying near dusk towards a roost site on an exposed sandbar ("Fernando's Fetch") near Muskeget Island. Many of these birds were too distant for estimates of altitude but none appeared to be flying higher than the daytime flocks

All records of tern altitudes were made when observational conditions were excellent to fair. It is important to recognize that most commuters probably reach their overnight destinations before nightfall and leave after dawn and are therefore unlikely to travel past turbines at night. Terns do fly near the colony or roost at night but most are thought to rest for most of the time. Terns taking off on migration across the ocean directly towards their wintering grounds would not cross the proposed turbine field.

3.1.7 Summary

From the studies/surveys conducted in 2001 - 2003, it is apparent that Common Terns forage in Nantucket Sound throughout their residence in Massachusetts (May to September). However, the numbers at the proposed site for a Wind Park on Horseshoe Shoal are small relative to other parts of the Sound. Furthermore, terns observed in Nantucket Sound flew primarily below the height of the turbine rotors (75 feet (23 m)). It is likely that terns very rarely fly over the sea at altitudes at which they might be at risk of collision. The vicinity of the proposed landfall is not reported to be used by terns for nesting.

4.0 POTENTIAL IMPACTS TO THE COMMON TERN

4.1 Introduction

This section discusses potential biological and physical impacts of the proposed project to the Common Tern. For each species the potential effects during the three phases of the project (construction, operation/maintenance, and decommissioning) will be considered in relation to the following four components: (1) habitat modifications, which include transient effects during construction and decommissioning, as well as alterations for the duration of the project; (2) construction/operation activities and vessel traffic; (3) disturbance/displacement by the turbines and ESP; and (4) collision with the turbines. The first two components are present in all three phases of the project while the last two components are only applicable to the operation phase.

Construction

The proposed landfall for the project is on the northeastern side of Lewis Bay in Yarmouth, near the end of New Hampshire Avenue. The proposed landfall and vicinity is not reported to be used by Common terns for nesting or roosting. The intertidal area contains a concrete and stone seawall and very little open sand. Construction techniques will minimize disruption of the intertidal zone through the use of Horizontal Directional Drill (HDD) to make landfall for the submarine cable system. For more information, see Section 4.3.4 of the DEIS-DEIR.

Offshore construction work is anticipated to take approximately 14 months spread over two construction seasons and will involve technologies of pile-driving hammers for installing monopile foundations and jet plow embedment for burying the submarine cable system and inner-array cables (Section 4.3.4). These techniques will minimize the area on Horseshoe Shoal affected by a temporary increase in suspended solids that might influence fish and foraging terns. The construction vessels will travel to the project site from Quonset, Rhode Island. If conditions require the use of helicopters to transport personnel, it is anticipated that they will travel to the project site from either New Bedford or Barnstable Airports.

Operation

The cable system 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 cable systems for the Project 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 and inner-array cables (See Section 5.13 of the DEIS-DEIR). These cable systems are not expected to have any effects on birds.

The WTG site will consist of 130 WTGs, the ESP and array of cables describe in section 2.1. Impacts to Common Terns during operation may result from collision with turbine blades during courtship displays, foraging and commuting. An in depth analysis of impacts is addressed below in Section 4.2.

Decommissioning
Decommissioning will entail removal of cables and all infrastructure within the WTG site to the level of the seabed. Effects on water quality and noise are expected to be similar to the anticipated effects during construction.

4.2 Analysis of Impacts

4.2.1 Habitat Modification

The primary water quality concern will be elevated concentrations of Total Suspended Solids (TSS) associated with construction and decommissioning of the project. Sustained elevated concentrations of TSS may dispel Common terns which would result in a potential direct effect if their prey is made invisible, or an indirect effect by potentially changing prey populations or local distribution. 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.

It is anticipated that the WTGs will be installed in approximately 13 strings, each comprising 10WTGs with associated inner-array cable and scour mats. Completion of each string and installation of the ESP are each anticipated to take approximately one month to complete. The installation of the submarine cable system from the ESP to the landfall via jet plow embedment is anticipated to take approximately two to four weeks to complete. Construction activities associated with installing the monopile foundations, scour protection mats, and submarine cables will result in a temporary and localized increase in suspended sediment concentrations. The vibratory or 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 disturbance of sediment to a minimum. Due to the predominant presence of fine to coarse-grained sand in Nantucket Sound, localized turbidity associated with Wind Park construction and decommissioning activities is anticipated to be minimal and generally confined to the area immediately surrounding the piles and within the narrow limits of the submarine cable system trench areas. Seabed sediments temporarily disturbed by construction activities are expected to settle back to the sea floor within a few tidal cycles after completion of construction in sandy seabed areas. In total, about one percent of the Project Area is expected to receive temporary impacts from construction: this comprises about 0.04 percent of Nantucket Sound. In addition, the Project Area is situated in a naturally dynamic environment that is subject to higher suspended sediment concentrations at the seabed/water interface as a result of relatively strong tidal currents and wind and storm generated waves, particularly in shoal areas. Therefore, marine organisms in this area are adapted to mobile bed and high suspended sediment concentrations due to natural conditions and populations are expected to recover rapidly from a temporary elevation of suspended sediment levels from Project activities. Mobile organisms are expected to opportunistically recolonize the disturbed sediments from adjacent areas (see section 5.3 and 5.4 of DEIS-DEIR for details).

Sediment suspension during construction and decommissioning activities is expected to last no longer than a few tidal cycles and will not result in long-term 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. Most avian species that may be present in the vicinity of the Project Area during construction are not expected to be adversely affected by temporary increases in TSS because they can move to other areas.

Another potential direct and cumulative effect could be bioaccumulation of chemical contaminants. Recent studies, however, indicate that there is little potential for birds to bioaccumulate chemical contaminants in their tissues from consuming prey in the Project Area during the brief period of construction. Analysis of 27 sediment core samples obtained from the Project Area indicated that sediment contaminant levels were below established thresholds in reference sediment guidelines. All of the chemical constituents detected in the sediment core samples had concentrations below Effects Range-Low (ER-L) and Effects Range-Median (ER-M) marine sediment quality guidelines (Long et al., 1995). The ER-L and ER-M guidelines use numerous modeling, laboratory, and field studies to establish values for evaluating marine and estuarine sediments. Concentrations below the ER-L represent a concentration range in which adverse effects are rarely observed. Section 5.1 of the DEIS-DEIR has more detailed information on sediment quality in the Project Area.

Based on the absence of potentially harmful chemical constituents in the marine sediments analyzed for this project, the temporary and localized disturbance and suspension of these sediments during project construction and decommissioning activities is not expected to adversely affect marine water quality conditions and fish populations in these areas of Nantucket Sound and thus is not expected to have an effect on the Common Tern. Any small amount of contaminants that might be present in suspended sediments is likely to remain adsorbed to sediment particles and be rapidly redeposited onto the bottom as the particles settle. It is unlikely that measurable increases in concentrations of some chemicals in the water column will occur, and thus, no direct or cumulative adverse affects on avian species that may be present in the vicinity of project construction and decommissioning are expected.

4.2.1.1 Effects of Underwater Structures

The presence of 130 WTGs and the ESP piles in Nantucket Sound has the potential to cause a localized change from a non-structured system to a structure-oriented system, with potential localized changes to benthic and finfish community assemblages. Both pelagic and more demersal finfish species (including small schooling species upon which terns feed) may tend to congregate around the WTGs more frequently than if a structure was not present (see Section 5.4 of the DEIS-DEIR).

Since the individual towers within the array will be spaced approximately 0.34 mile by 0.54 nautical mile (0.63 km by 1.0 km) apart, substantial changes from pre-Project conditions are not anticipated. Any changes will likely be localized and it is unlikely that these isolated structures will impact (either positively or negatively) the overall environment or species composition of the Project Area or Nantucket Sound. In the immediate vicinity of the monopiles there may be changes in the fish community that affect tern prey positively (e.g. new species), or negatively (e.g. new predator), but the scale of these effects will be very small in the context of the whole Sound. Please refer to Section 5.3 and 5.4 DEIS-DEIR for more details.

4.2.1.2 Effects of WTG Access Platforms and ESP

Although the turbine towers will give no sites for birds to perch below the nacelle, a pre-fabricated access platform and service vessel landing located around each tower at about 30-35 feet (9-11 m) from MLLW and the centralized electric service platform (ESP) will provide potential resting sites for terns, gulls, cormorants, and other species. For some birds familiar with the turbines this may be beneficial, enabling more efficient use of foraging time. However, terns commonly initiate courtship flights from such resting areas (not only near the colony), which bring them to the range swept by the rotors, thus increasing risks of collisions.

In order to reduce the risks to terns and other bird species, these platforms will incorporate elements designed to prevent birds from perching upon them.

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. The system will be passive and incorporate stainless wire and vision restriction. In addition to the passive deterrent, the WTG's will be operating most of the time resulting in vibrations and low level noise that may also discourage usage by avian species.

Each WTG has a transition piece on top of the pile that has an access ladder and boat fender system connected to a deck. The deck is round through 180 degrees and has an extended section on one side. The diameter of the transition piece is 5.39 m with a deck that is 8 m diameter with the extension section of 7.4 m 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 deterrent system consists of the fence to prevent access from the side, a stainless wire on top of the railing and a .65 m solid panel to restrict visibility of any avian species from the deck. This system will take advantage of the preferences of web-footed birds to perch on near-flat surfaces with views of their surroundings.

The wire will be 3 mm stainless steel marine wire with swage lock terminals and turnbuckles to connect it to posts at appropriate locations and maintain it taught. The spacing between the rail and the wire will be 3 cm. The size selected was to allow visibility of the wire to various species while being too small to perch upon.

The electric service platform (20,000 ft^2 (1,858 m^2)) is likely to be used frequently by birds because it will not be continuously manned. Maintenance visits to the Wind Park are likely to occur on about 250 days per year and night time use will be minimal (see Section 4.1.4 DEIS-DEIR). Two potential bird uses of the ESP are pertinent to this Biological Review: 1) individual Common Terns will use various perches around the edges of the platform as vantage points from which to watch for prey below and as the base for feeding territories from which to drive other terns. Foraging terns are generally below the height of the rotors so that any such increases in foragers are unlikely to represent risks and need not be discouraged; and 2) numerous species of birds, not only Roseate and Common Terns, are likely to use any suitable flat surfaces of the upper decks as places to rest by day and perhaps also by night (roosting). From such resting flocks of terns in May and June, potential pairs initiate high courtship flights during which they could drift downwind to a nearby turbine (distance 1,640 feet (500 m) or more) where they would be at risk of collision. The platform is likely to attract terns throughout their residence in the Sound (April – September) and other birds, notably gulls and cormorants, throughout the year. Some birds might nest there if a suitable site were available.

The ESP has an overall size of 60 m x 30 m consisting of a building like superstructure sitting on a 6 pile structural support. The superstructure overhangs the support. The bottom of the superstructure is 11.5 m from MLLW and the top of the heliport deck is 30 m. The top deck will have a perimeter railing.
The deterrent system used for the ESP will be the same as the WTG's in that all ladders and railings will have the same treatment of stainless steel wire, chain-link fence and solid panels.

A final, complete deterrent design will be based on the success of this approach on the existing Cape Wind Scientific Measurement Devices Station (SMDS) as well as existing literature and recommendations from USFWS, USDA and consultants or vendors of bird deterrent technology. Bird deterrent methods have thus far proven effective on the SMDS that is currently situated in Nantucket Sound. Prior to "bird-proofing" this tower in June 2003, terns were observed resting on the fence and the decking of the platform. None have been observed since the installation of the bird deterrents.

4.2.2 Disturbance from Construction and Vessel Traffic

Neither noise nor visible activities from construction at reasonable distances are likely to affect Common terns, which are known to nest successfully in close proximity to airports and to feed close to vessels. Vessel traffic will be greatest during construction and will continue during the operational phase, when maintenance trips are expected on about 252 days per year, which would include one crew boat from Falmouth and the maintenance support vessel from New Bedford. In addition an occasional second round trip from Falmouth could take place in times of fair weather or for emergency service. These estimates are based upon the calculations derived from the Operations and Maintenance (O&M) Plan (see Section 4.4 of the DEIS-DEIR). At expected distances, the presence of vessels would have negligible effects on foraging by terns. Helicopters will be used occasionally and may have effects on birds over a greater range than boats, but these effects are local and ephemeral. The helicopter-landing platform will allow for crews to be deployed to the ESP during periods when wind and wave conditions are unsuitable for boat transfers, and in case of emergency.

4.2.3 Disturbance-Displacement by Turbines

Disturbance-displacement by turbines and barrier effects of lines of turbines that exclude individuals from certain areas, leading to habitat loss, are thought to have direct impacts on some birds, especially those species that inhabit open landscapes and tend to avoid tall vertical structures, e.g. grassland species (Leddy et al. 1999; Langston and Pullan 2003). However, for terns, there is no evidence to suggest adverse effects from the proximity of turbines; lines of turbines were no barrier to movements of terns and gulls nesting nearby (van den Bergh et al. 2002). No displacement from habitat is expected for the Roseate Tern. Piping Plover habitat will not be impacted at the WTG site because plovers do not occur offshore except when traveling to new feeding areas (as at the end of the breeding season) or migrating. For terns there is no evidence to suggest adverse effects from the proximity of turbines, as indicated in the preceding paragraphs, so no displacement from habitat is expected to the Common Tern.

4.2.4 Collision with Turbines and Other Infrastructure

Terns very rarely collide with large stationary objects such as Lighthouses or communication towers, or with large moving objects such as ships, even when they are brightly light. Few records of such collisions are known from Massachusetts (Veit and Petersen 1993), even from Great Point Light in Nantucket Sound, and there seems to be little reason to expect that offshore objects will differ greatly. A recent example from a long-term study at Long Point Lighthouse in Lake Erie is instructive in indicating that terns are unlikely to collide even with an illuminated structure: during the period 1960 – 2001 a total of 18,158 dead birds were recorded, of which 2 were Common Terns and 54 were shorebirds (Jones and Francis 2003 Jones pers. comm.2004). This example is by no means definitive because numbers at risk are unknown, but thousands of terns nest on the Great Lakes and many thousands of shorebirds pass that way every year.

It is widely known that certain types of lighting attract birds, especially songbirds migrating at night and in inclement weather. However, lighting of the WTGs should have minimal impact on terns, not only because the proposed lighting is much less than a lighthouse but also because seabirds and shorebirds have not been demonstrated to be attracted to the lighting on communication towers (Shire et al. 2000, Avery et al 1980). Also, the lighting scheme proposed for the WTGs will have characteristics that are recommended not to attract birds. See Section 5.12 of the DEIS-DEIR for a description of the proposed lighting scheme. Thus, the risk of collision mortality of terns and plovers at turbine towers or at the ESP appears to be negligible.

Collisions with turbine blades cause some avian mortality. Reports of terns or shorebirds killed in collisions at wind farms are very rare. A recent summary of information on such avian mortalities from the United States identified no terns and only one shorebird, a Killdeer (Erickson et al., 2001), but these data are only suggestive because most wind farms are at inland sites where such birds are usually much less common than in nearshore marine habitats. In Europe, there is greater experience with coastal and offshore wind farms and some data are available for birds, although no data are available for terns or shorebirds at large offshore wind farms. It is likely that these birds collided with blades. At one coastal wind farm with 23 small and medium-sized turbines (200-600 kW), at Zeebrugge in Belgium (part of which was located amongst nesting Little Terns (*Sterna albifrons*)), five terns (3 Common, 2 Little) were reported as killed in year 2001 (Everaert et al., 2002); after correcting for inaccessible search areas, 28 were estimated as killed by collision that year. Many terns nested within about 2.5 mi (4 km) of these turbines: 2,250 pairs of Common Terns, 1,550 pairs of Sandwich Terns, and 200 pairs of Little Terns. Most of the terns observed at this site flew below rotor height (49-164 feet (15-50 m) rotor-swept area). During daylight hours very few of the Little Terns flying past the turbines at rotor height (or above) visibly reacted to them (5 reacted/850 observed). For Common Terns, which nested further away (>1.1 mi (1.8 km)), on the other hand, 17/90 reacted. Such data suggest that terns both detect the presence of the turbines and become accustomed to them. The findings at this wind farm are not entirely appropriate for quantitative extrapolation to Nantucket Sound for numerous reasons, of which two are particularly significant: the proposed rotor-swept area will be much higher (75 - 417 feet (23 - 127 m)) and there will be neither resting areas nor nesting birds nearby.

A second coastal wind farm located in an area frequented by terns is at Blyth, Northumberland, in northeastern England (Painter et al., 1999, 2002). At this site nine 300 kW turbines were erected on a breakwater in 1992, and two 2 MW turbines were constructed about 1 km offshore in December 2000. This wind farm is about 13.7 mi (22 km) from tern colonies at Coquet Island. Monitoring that began in 1991 (pre-construction) and continues post-construction has included regular coast-based observations of bird movements by day and night and beach surveys for dead birds. Terns have been seen near the turbines by day but not by night and very small numbers were encountered in the beach-carcass surveys; none of the latter were identified as collision mortalities. During the seven-year period since the wind farm was commissioned only about 3 percent of the bird corpses found on the beaches were attributed to the wind farm and a majority of those were gulls. One shorebird species of special concern in Europe, the Purple Sandpiper (*Calidris maritima*) occurred at the site. Its winter roost adjacent to the turbines was unaffected.

Collisions of Common Terns with power lines near a colony of 500 birds in the UK were examined by Henderson et al. (1996). The two groups of cables were 328-656 feet (100-200 m) from the colony and were <33 feet (10 m) asl at their low points. Two collision-mortalities were recognized, and "near-misses" and evasive maneuvers were frequently observed as terns flew between the colony and feeding areas. The wires were generally below the height of the proposed turbine rotors thus the data do not apply directly to the wind farm.

In conclusion, while some collision mortalities may occur, these are unlikely to be detected and numbers will be very low, too low to affect populations of Common Terns. No biologically realistic or precise prediction of number killed is possible with the available data.

4.3 Summary/Conclusion of Impacts

Based upon the analysis of potential impacts, it is unlikely that significant adverse effects to the Common Tern will result from the construction, operation/maintenance, and/or decommissioning of this project. Based on the absence of potentially harmful chemical constituents in the marine sediments analyzed for this project, the temporary and localized disturbance and suspension of these sediments during project construction and decommissioning activities is not expected to adversely affect marine water quality conditions or fish populations in these areas of Nantucket Sound and thus is not expected to have an effect on the Common Tern. Habitat changes resulting from the presence of the turbines are not expected to have net adverse effects on the food supply of terns, nor will the turbines exclude terns from foraging habitat. Although vessel traffic will increase slightly during the period of the project, this will have a negligible effect on foraging terns. The risk of mortality or injury from collisions with rotors or towers is unknown but is judged to be very small. The WTG access platforms and the ESP may provide opportunities for terns to perch and thus increase chances of collisions during courtship flights, but deterrents will be used to minimize this as discussed in Sections 5.3 and 5.4 below.

5.0 MANAGEMENT PRACTICES/MITIGATION

The following paragraphs address the alternative locations for the Wind Park as well as some features of the turbines that have been adopted as potential mitigation or prevention of potential impacts to birds.

5.1 Location

Three possible locations for the Wind Park in Nantucket Sound have been identified: the proposed Site (Alternative #1) is on Horseshoe Shoal, with alternatives to the northeast (Alternative #2, named Monomoy/Handkerchief Shoal), and south (Alternative # 3, Tuckernuck Shoal). For the Common Tern, Alternative Site #1 is the preferred of these alternatives because it is the most remote from the large colony on Monomoy and the roosting sites and staging areas. The largest of these pre-migratory aggregations is on South Beach, but several sites on the south edge of the Sound are also important (Eel Point (Nantucket), Tuckernuck, Muskeget, and Fernando's Fetch). The observed use of the alternative areas is given by data from the Cape Wind summer aerial surveys in 2002 (see Appendix 5.7-F): measured tern densities as terns/sq km were 4.62 on Site #1, 3.57 on Site #2, and 5.36 on Site #3. All these values are similar and very low.

5.2 Turbines

Although no quantitative comparisons have been made at offshore sites, it is likely that the proposed 3.6 MW turbines are to be preferred to smaller turbines on lower towers, because higher turbines are expected to reduce risks of collision for terns that generally fly close to the surface of the sea. The towers are tubular, rather than lattice, which reduces perching opportunities for virtually.

5.3 Turbine Access Platform

Near the base of each turbine tower there will be access for servicing the WTG. The standard model includes a flat platform about 30-35 feet (9-11 m) above MLLW that may be a convenient resting place for terns, gulls, cormorants, and other species. As discussed in Section 4.2.1.2, this could be beneficial to some species by offering a resting area, but may increase the risk of collision with the WTGs for terns during courtship flights.

However, the fence on the perimeter of the platforms will be equipped with bird deterrent devices to deter terns from perching as previously discussed in Section 4.2.1.2. A final, complete deterrent design will be based on the success of this approach on the existing Cape Wind Scientific Measurement Devices Station (SMDS) as well as existing literature and recommendations from USFWS, USDA and consultants or vendors of bird deterrent technology.. Bird deterrent methods have thus far proven effective on the SMDS that is currently situated in Nantucket Sound. Prior to "bird-proofing" this tower in June 2003, terns were observed resting on the fence and the decking of the platform. None have been observed since the installation of the bird deterrents.

5.4 Electric Service Platform

The ESP (20,000 ft^2 (1,858 m^2)) is likely to be used frequently by birds because it will not be continuously manned. Maintenance visits to the Wind Park are likely to occur on about 250 days per year and night time use will be minimal (see Section 4.4 DEIS-DEIR). The platform is likely to attract terns throughout their residence in the Sound (April – September) and other birds, notably gulls and cormorants, throughout the year. Some birds might nest there if a suitable site were available. In order to reduce the risk to terns that may initiate high courtship flights from the ESP (see Section 4.2.1.2), the ESP will be constructed with deterrents so as to be unsuitable for use by birds. Deterrent methods included securing wire above the top of the platform fence and other areas where birds may perch. This method has proven successful on the existing SMDS. The turbine platforms and ESP will be monitored closely post-construction to ensure that the opportunity for birds to perch is not available. Recommendations by the USFWS USDA, consultants and vendors of bird deterrent technology will also be employed.

5.5 Lighting

Currently, design plans call for lighting the WTG towers with flashing lights to meet FAA and USCG safety requirements. The proposed WTG lighting does not possess the characteristics that are known to attract birds and includes some of the features recommended by the USFWS in Guidelines for Communications Towers, for reducing potential bird problems on land. Preliminary evidence for the breeding season suggests that terns are not often active at sea at night so lighting of the WTGs would pose little risk to the Common Tern. For further detail on the lighting design and potential effects on other bird species, see Section 5.12 of the DEIS-DEIR.

6.0 CONCLUSION

The available evidence indicates that the Cape Wind Project is not likely to jeopardize the continued existence of, nor present significant risks to, the Common Tern, nor adversely modify designated critical habitat. Some infrequent collision mortality is possible but this small risk cannot be estimated precisely.

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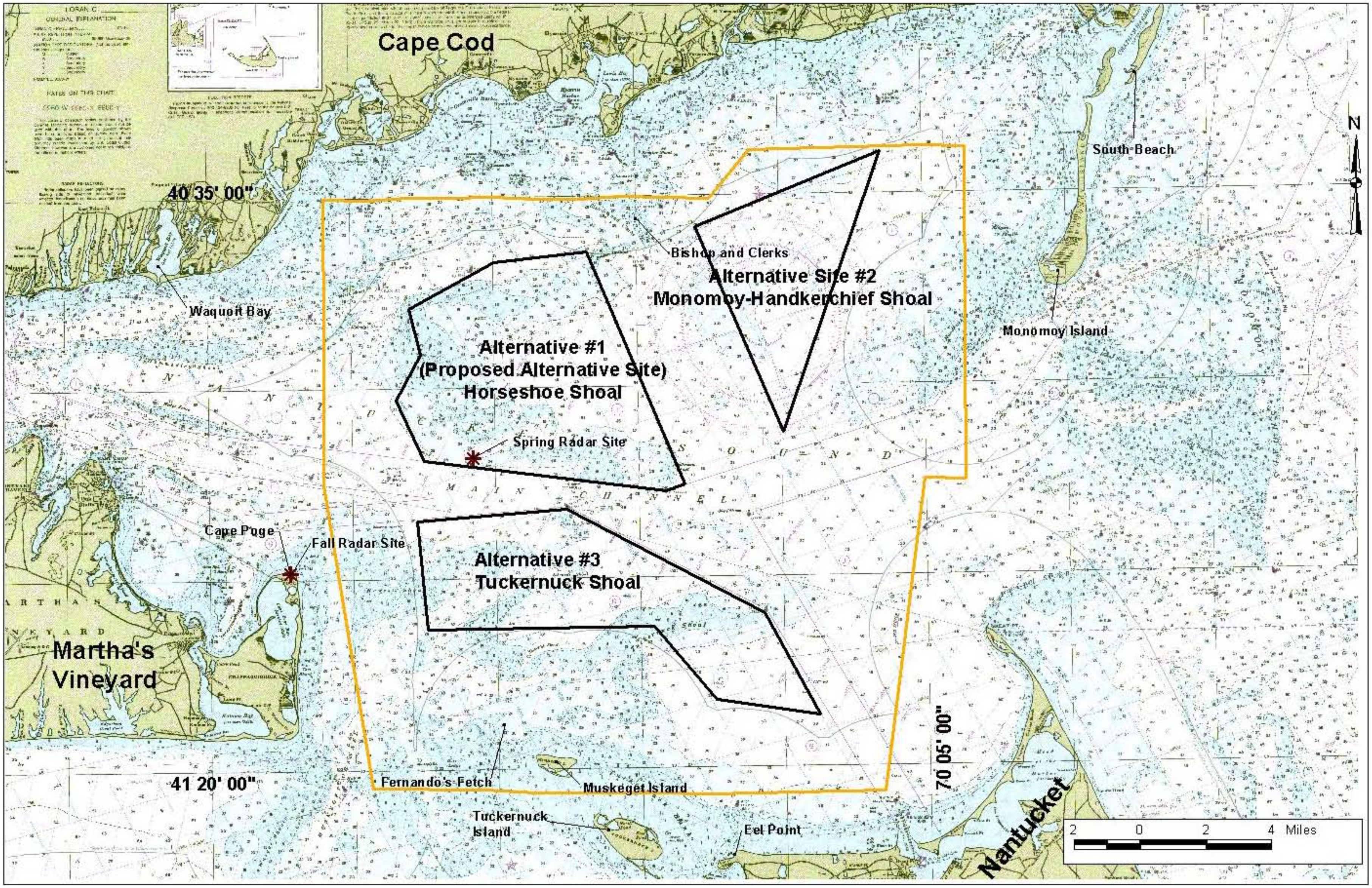
Figures



Cape Wind
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ESS
Group Inc.
Engineers
Scientists
Consultants

Cape Wind Project
Alternative Boundaries
Study Area
20% of Study area was flown

Source: MASSGIS – NOAA Chart #13237
Cape Wind Associates Field Surveys March 2002 – February 2004

Study Area, Alternatives, and Important Features for the Cape Wind Project

Figure 1