# 4.0 DESCRIPTION OF THE AFFECTED ENVIRONMENT

## 4.1 PHYSICAL RESOURCES

For purposes of describing the physical resource characteristics of the proposed action area, this material is presented in the following seven subsections: geology, noise, physical oceanography, climate and meteorology, air quality, water quality, and electrical and magnetic fields.

### 4.1.1 Regional Geologic Setting

The site of the proposed action is located in the Atlantic Coastal Plain physiographic province. The geomorphologic setting can best be described as glacially produced. The surficial expression of Cape Cod and Nantucket Sound were formed during the advance and retreat of the last continental ice sheet in the northeastern United States, part of the Laurentide glaciation, and the subsequent erosion and reworking of the glacial deposits during the Holocene (10,000 years ago to the present) sea-level rise. Figure 4.1.1-1 (see Appendix A for all Figures) presents an interpretation of the glacial processes that formed Cape Cod and Nantucket Sound.

In the area of the proposed action, the maximum advance of the last continental glaciation is marked by the advance of the Cape Cod ice lobe, and the formation of terminal moraines on Martha's Vineyard and Nantucket, estimated at approximately 20,000 years ago. During this advance, it is thought that subglacial tunnel valleys carrying meltwater and sediment, extended south from Cape Cod to the ice margin near Martha's Vineyard and Nantucket, and eroded into the underlying fine grain sediments (Uchupi, E. and Mulligan, A.E., 2006).

As the continental ice sheet retreated, a proglacial lake formed in Nantucket Sound, resulting in the deposition of clays and fine sand. During this retreat, the ice sheet stalled along the southern shore of Cape Cod, depositing unstratified, poorly-sorted, ice-contact deposits of silt, clay, sand, gravel, and boulders (see area "III" in Figure 4.1.1-1). As ice-sheet retreat continued, this unstratified glacial deposit formed a dam and a second glacial lake formed to the north (see area "IV" in Figure 4.1.1-1). Fine-grained sediments were deposited into this second glacial lake. As the ice-sheet continued to retreat, this second dam, located along the southern shore of present day Cape Cod, failed, and the glacial lake on Cape Cod joined glacial Lake Nantucket. This event was followed by failure of the dam that formed Lake Nantucket, resulting in extreme erosion of the glacial lake and basement sediments. As the ice-sheet continued to retreat, fluvial deposition resulted in the formation of outwash plains on Cape Cod and Nantucket Sound (U.S. Geological Survey [USGS], 2006a; Uchupi, E. and Mulligan, A.E., 2006).

As the ice-sheet continued to retreat, another glacial lake formed to the north, in Cape Cod Bay, north of the present day Cape Cod outwash plains and the moraine that formed in central Cape Cod. The water level in this glacial lake was higher than today's sea-level, and groundwater seeps formed on the outwash plain. The unique combination of sand and gravel outwash plains and plenty of source water emanating from the seeps resulted in the formation of straight fluvial valleys that flowed south across the present day Cape Cod outwash plains and Nantucket Sound (Mulligan, A.E. and Uchupi, E. 2004; USGS, 2006a).

During this glacial event, world-wide sea-level was hundreds of feet lower than current levels, and the Earth's crust was depressed by continental glacial loading. As the Laurentide ice sheet continued to melt, sea-level continued to rise, ultimately transgressing over the present day offshore sediments in the project area, drowning the lower reaches of the straight fluvial valleys that had formed, eroding and reworking the glacial deposits along the southern Cape Cod coastline and in Nantucket Sound, a processes that continues today (USGS, 2006a).

Figure 4.1.1-2 presents the present day regional onshore surficial geology of Cape Cod, Martha's Vineyard, and Nantucket. Figure 4.1.1-3 presents the present day regional surficial geology of Nantucket Sound. Figure 4.1.1-4 presents surface sediment types in the proposed action area of Nantucket Sound.

To further understand the regional sedimentary features, two regional geologic cross sections were constructed. Figure 4.1.1-5 presents the locations of two cross sections, identified as A-A′ and B-B′. Figure 4.1.1-6 presents the geologic cross section A-A′, which begins onshore in southwestern Cape Cod, extends through the site of the proposed action in Nantucket Sound, and continues to Nantucket Island. Figure 4.1.1-7 presents geologic cross section B-B′, which begins on Martha's Vineyard, extends through the site of the proposed action, and continues onshore in the mid-Cape Cod region.

### *4.1.1.1 Site-Specific Studies Analysis*

Field studies were completed to further refine the understanding of the geology at the site of the proposed action as it relates to the seafloor, sub-seafloor, and onshore cable route. Studies were targeted to detail water depths, surface and sub-surface sediment types, seafloor morphology, sub-seafloor stratigraphy, and natural or man-made obstructions as they relate to installation, operation, and decommissioning of the proposed facilities. Benthic and archaeological samples were incorporated into the geotechnical field programs, where applicable (Report No. 4.1.1-1). Integrated marine geophysical/hydrographic surveys and geotechnical/sediment sampling programs were conducted in 2001, 2002, 2003, 2004, and 2005 on Horseshoe Shoal and along the proposed transmission cable route from the ESP to the proposed landfall location in Yarmouth.

Numerical modeling and engineering analysis of site specific data related to oceanographic processes was performed to assess, simulate, and predict potential impacts to geologic resources for installation and operation of the proposed action. The studies included: Report No. 4.1.1-2 *Simulation of Sediment Transport and Deposition from Cable Burial Operations in Nantucket Sound for the proposed energy Project;* Report No. 4.1.1-3, *Estimates of Seabed Scar Recovery from Jet Plow Cable Burial Operations and Possible Cable Exposure on Horseshoe Shoal from Sand Wave Migration*; Report No. 4.1.1-4, *Analysis of Effects of Wind Turbine Generator Pile Array of the Project in Nantucket Sound*; Report No. 4.1.1-5, *Revised Scour Report;* Report No. 4.1.1-6, *Conceptual Rock Armor Scour Protection Design,*; Report No. 4.1.1-7, *Hydrodynamic Analysis of Scour Effects Around Wind Turbine Generator Piles, Use of Rock Armor and Scour Mats, and Coastal Deposition and Erosion*; and, in Report No. 4.1.1-8, *Seabed Scour Control Systems Scientific Design Station Report*. A detailed summary of these studies is presented in Section 5.3.1.1.

As detailed in Section 5.3.1.1, if the proposed action is authorized, the applicant would conduct additional geophysical/hydrographic surveys, geotechnical/sediment sampling vibracore sampling, and cone penetration test samples along the proposed 115 kV cable routes and along the inner-array 33 kV cable routes to finalize design parameters. All future survey and sampling methods will be site specific and coordinated with MMS.

#### 4.1.1.1.1 Marine Geophysical/Hydrographic Surveys

The marine geophysical/hydrographic surveys were designed to collect remote sensing data to evaluate wind tower installation feasibility, gather data to support the foundation design process, and to support the analysis of the surface and subsurface sediments on Horseshoe Shoal and the proposed submarine transmission and inner-array cable routes. Surveys included:

- Hydrographic measurements with a fathometer to determine water depths;

- Side-scan sonar to evaluate surface sediments, seafloor morphology and potential surface obstructions;
- Seismic profiling with high frequency (HF) (high resolution; limited penetration below the seafloor) and low frequency (low resolutions; deeper penetration beneath the seafloor) acoustic sources; and
- Magnetometer surveys to identify ferrous objects at the surface or shallow subsurface areas; combined with a differential Global Positioning System (GPS) to document the precise location of anomalies.

Figure 4.1.1-8 illustrates the locations of the 2001, 2003, and 2005 marine geophysical and hydrographic vessel tracklines, as they relate to the proposed action facilities.

Following completion of the field survey, the digital data files were processed at the surveyor's mainland facility, then reviewed and interpreted by staff and a marine archaeologist (for potential cultural resources). Digital hydrographic files were corrected for tidal fluctuations to report water depths at MLLW. Side scan sonar and magnetic intensity data were interpreted to delineate acoustic targets and magnetic anomalies.

#### 4.1.1.1.2 Geotechnical Investigations

Two marine sediment sampling methods, vibracoring and sediment boring were used to advance sediment sampling devices below the seafloor surface to collect, sample, and analyze representative sediments from the site of the proposed action. The information gathered during these studies was used to correlate the geophysical data collected to actual sediment characteristics where WTG foundations are proposed in deep sediment (85 ft [26 m] below the seafloor) and along shallow electrical inner-array cable routes in shallow sediment depths (targeted for 6 ft [1.8 m] below the seafloor).

In addition, soil borings and test pits were completed along the onshore transmission cable route to confirm the surficial materials expected to be encountered during transmission cable installation.

Figures 4.1.1-8 and 4.1.1-9 illustrate the offshore locations of the marine vibracores, the geotechnical/sediment sampling, and the wind turbine locations.

Figure 4.1.1-10 illustrates the geotechnical boring and test pit locations along the onshore cable route.

#### 4.1.1.1.3 Marine Vibracore Sampling

A total of 87 vibracores were advanced to confirm geophysical survey interpretations, to visually characterize the sediment, and to collect representative samples for physical property and chemical constituent analysis. Three of the vibracores collected were used to support the marine archaeological investigation.

Vibracores were advanced and collected from a ship. The cores were labeled and capped on the ship and transported to shore for analysis. Cores were advanced up to 30 ft (9.1 m) below the seafloor in the wind turbine field grid and typically to 10 ft (3 m) below the seafloor along the transmission cable route. Onshore, cores were opened, photographed, and were described in accordance with the Unified Soil Classification System.

##### 4.1.1.1.4 Deep Sediment Marine Borings

A total of 22 deep sediment marine borings were advanced, to a maximum depth below the seafloor of 150 ft (45.7 m), to collect geotechnical information as it relates to the below seafloor depths of the proposed wind turbine foundations.

Deep sediment borings were advanced from a ship. Sampling devices, split spoons, were driven ahead of drilling tools to collect representative sediment samples. Standard penetration test blow counts were recorded. Sediment recovered in the split spoons was characterized, and at various applicable locations, field tests included pocket penetrometer and torvane tests to estimate the un-drained shear strength of the cohesive soils encountered. Grain size and Atterberg Limits analyses were performed on sediment samples and pressuremeter tests were performed at select locations to measure the in situ strength and deformation characteristics of the sediment. The pressuremeter tests can be used to assess the bearing capacity and settlement of foundations.

##### 4.1.1.1.5 Upland Geotechnical Boring and Test Pitting

Four soil borings and three tests pits were completed along the pre-existing roadway ROWs and the NSTAR ROW to confirm the existing upland soil conditions.

#### *4.1.1.2 Offshore Geology*

The offshore portion of the area of the proposed action is located primarily in the central region of Nantucket Sound with the two transmission cables extending northward into Lewis Bay and the southern shoreline of Cape Cod.

##### 4.1.1.2.1 Seafloor Geomorphology

The area of the proposed action is located in Nantucket Sound, a broad passage of water that separates the south shore of the Cape Cod mainland and the islands of Nantucket and Martha’s Vineyard, and Lewis Bay, a coastal embayment along the south coastline of Cape Cod. The foundations for the WTGs and the ESP are proposed for installation on Horseshoe Shoal, located within Nantucket Sound.

In general, the bathymetry in Nantucket Sound is irregular, with a large number of shoals present in various locations throughout this basin. A combination of NOAA nautical charts and project-specific hydrographic surveys were used to assess existing bathymetric conditions.

On Horseshoe Shoal where the WTGs and the ESP are proposed, hydrographic surveys indicate water depths are as shallow as 0.5 ft (0.15 m) (MLLW), with depths of up to 60 ft (18.3 m) (MLLW) occurring between the northern and southern legs of the shoal. The WTGs and ESP would be located in water with depths between 12 and 50 ft (3.7 and 15.2 m) (MLLW).

Water depths between Horseshoe Shoal and the Cape Cod shoreline have an average depth of approximately 15 to 20 ft (4.6 to 6.1 m) (MLLW). Along the proposed transmission cable system route, water depths range from 16 to 40 ft (4.9 to 12.2 m) (MLLW), with an average depth of approximately 30 ft (9.1 m) (MLLW).

In Lewis Bay, water depths range from 8 to 16 ft (2.4 to 4.9 m) (MLLW) in the center of the bay to less than 5 ft (1.5 m) (MLLW) along the perimeter. Water depths along the proposed transmission route in Lewis Bay range from 2 to 16 ft (0.61 to 2.4 m) (MLLW).

Marine geophysical surveys present a seafloor that ranges from flat and barren to rolling with areas of varying height sand waves. Localized areas of glacial erratics (pebble to boulder size rock fragments carried by glacial ice), and a concentrated outcrop of possible till (an unstratified glacial deposit that can include clay, silt, sand, cobbles, and boulders) were observed. This possible till deposit has been avoided during the selection of the final proposed transmission cable alignments. In addition, the side scan geophysical imagery was indicative of coarse glacial material (gravel, cobbles, and boulders) and intermingled with man-made debris (generally from 1 to 5 ft [0.3 to 1.5 m] in size) on the seafloor in the west central part of the proposed action area.

**Sand Waves and Sediment Transport**

The sand waves observed during the geophysical surveys are wave-like seabed features, with elongated, more or less parallel crests. Typically, sand waves are not static, rather they are migrating bedforms and evidence of active sediment transport along the seabed. Sand waves in this shoal environment are morphologically dynamic, with sand waves moving, appearing, disappearing, and changing shape over time as a result of tidal and storm influences. This sand wave process is not unique to Nantucket Sound, but rather occurs in coastal settings wherever the appropriate hydrodynamic conditions exist along with a predominance of sandy, non-cohesive sediments.

Sand waves of varying heights characterize the areas of active sediment transport, generally in the center of the Horseshoe Shoal. However, a large field of sand waves extends across the southern half of the shoal, and several smaller fields are located to the north within the area of the proposed action. Figure 4.1.1-11 presents the location and maximum observed heights of sand waves identified during geophysical surveys completed in 2003 and 2005, and includes the locations of the proposed WTGs and the electrical transmission cable routes.

The sand wave crests are oriented generally in a north-south direction, with long period wavelengths ranging from 100 to 600 ft (30.5 to 182.9 m). Short period sand waves are located between the larger crests. The average sand wave height observed was 4 to 5 ft (1.2 to 1.5 m), but waves as high as 12 ft (3.7 m) were present. Smaller wave heights from 1 to 2 ft (0.3 to 0.61 m) were often observed between the larger wave crests.

Tidal currents flow east and west across the Nantucket Sound, with the eastward-flowing flood tide more dominant than the westward-flowing ebb tide. The symmetry of the sand waves indicates migration to the east or west, depending on where they formed on the Horseshoe Shoal. Sand waves forming on the west flank of the shoal tend to migrate easterly. Sand waves forming on the east flanks of the shoal tend to migrate to the west. Sand waves across the crest of the shoal have a symmetrical profile, suggesting an equal force in both the ebb and flood tidal phases. Not all bed forms exhibit a clear migration direction, indicative of multiple processes impacting sediment transport in Nantucket Sound, include storm events.

Analytical sediment transport modeling was completed to determine the extent to which existing wave and current conditions are likely to lift and move sand at the site of the proposed action. A two-dimensional sediment transport model was developed to simulate 26 current and wave conditions across the site of the proposed action. The model inputs included a grid of wave heights and ambient currents for the site of the proposed action. The model then calculates near bottom velocities and shear stresses associated with waves and ambient currents. The model results represent whether and where sediment transport is likely to occur and potential rates of bed load and suspended load sediment transport (Report No. 4.1.1-9).

Ten tidal and wind driven current scenarios were run for Horseshoe Shoal. The conditions were selected to represent a range of tidal currents, locally-generated wind waves within Nantucket Sound, ocean waves, and wind-generated currents in the sound. Extreme conditions, such as storms, were not modeled. The results of the model runs are useful in understanding the dynamics of sediment transport in

Nantucket Sound under different conditions. However, qualitative sediment transport rates and net sediment flux within Horseshoe Shoal are not possible without field measurements for model verification (Report No. 4.1.1-9).

The results of the modeling indicate that active sediment transport occurs at Horseshoe Shoal under typical wave and tidal current conditions. The highest sediment transport rates are focused locally on the shallowest portions of the shoal, and there is relatively little sediment transport in the deeper regions of the shoal (particularly the east side) under typical conditions. Bed load transport is typically an order of magnitude greater than suspended load transport. The range of sediment transport volume from the energy flux calculation for mean flood tide conditions and commonly occurring waves (height = 1.3 ft [0.4 m], period = 2.3 seconds) is 0 to 32.3 cubic ft/ft-day (0 to 3.0 $m^3$/m-day), though the authors recognize that the model cannot account for erosion and equilibration of the seafloor and likely the rates predicted are overstated (Report No. 4.1.1-9).

Spring tidal currents and typical wind-driven currents (wind speeds ranging from 15 to 20 mph [6.7 - 8.9 m/s]) initiate approximately 20 percent more transport than mean tidal currents. The greatest impact on sediment transport initiation is wave action. Larger locally generated waves within Nantucket Sound can result in a significant increase in sediment transport. Storm generated ocean swells reaching the sound can greatly increase sediment transport rates, as much as one-hundred fold (Report No. 4.1.1-9). Jet-plowing operations would not be scheduled during or prior to any predicted extreme storm events and therefore were not included in the modeling. Additionally, jet-plowing would be suspended during any unanticipated extreme storm events.

#### 4.1.1.2.2 Subseafloor Geology

The sediment below the seafloor was characterized by completing geophysical surveys at all of the WTG locations and along electrical transmission cable runs, and the collection, characterization, and analysis of samples collected from 84 vibracores (not including three archeological cores) and 22 deep borings on Horseshoe Shoal. On Horseshoe Shoal, vibracores were advanced up to 20 ft (6.1 m) below the seafloor. Geotechnical borings were advanced below the proposed depth of the WTG foundations (85 ft [26 m]) though one was extended to 150 ft (47.5 m) below the seafloor. Geophysical surveys characterized shallow and deep sediments, with bottom profiler gathering data to 200 ft (61 m) below the seafloor at some locations. In general, geotechnical surveys indicate that subsurface soil conditions within the WTG array on Horseshoe Shoal consist primarily of sands and glacial deposits to greater than 100 ft (30.5 m) below the seafloor.

Shallow sediment samples collected from vibracores (extended up to 20 ft [6.1 m] below the seafloor) between the WTGs indicates the shallow surficial sediments are primarily medium sand in shallow water and fine sand in deeper water. Characterization via bulk physical analysis was completed on composite samples collected from the upper 4 to 5 ft (1.2 to 1.5 m) of sediment collected from the vibracores. The samples collected from shallow water indicated the presence of well sorted sands with less than 5 percent fines. In the deeper waters, well sorted sand to silty sand was present. Detailed cross sections across Horseshoe Shoal A"-A'" and B"-B'" are presented as Figures 4.1.1-12 and 4.1.1-13, respectively; the plan view for cross section locations are presented in Figure 4.1.1-5.

Along the proposed transmission cable route in Nantucket Sound, sediment characterization samples were collected and analyzed and were found to be very similar to those in the WTG array area. Within Lewis Bay, a higher percentage of silt and clay were identified with the sands. In addition, thin layers of organic material, including thin (0.5 ft [0.15 m] thick) layers of peat, were observed. The geophysical sub-bottom profiles approaching Lewis Bay contain inconsistent (continuous, discontinuous) acoustic subsurface reflectors, which may be evidence of the fluvial erosion (during sea-level fall) and then wave erosion (during sea-level rise) that has occurred on the Cape Cod southern coastline (OSI, 2002 and 2003).

These shallow sediments are representative of the material to be disturbed (suspended during jet plow embedment) during the WTG inner-array cable installation, which is targeted for a depth of 6 ft (1.8 m).

Figure 4.1.1-9 presents vibracore sample locations and a plan view of a geologic cross section location along the 115 kV Cable Route from the WTG array to landfall. The cross section is presented in Figure 4.1.1-14.

Deeper sediments were characterized as re-worked fine to medium sands. Locally, intermittent beds of organics are located within and below this re-worked sediment. This is presented on the cross section presented in Figure 4.1.1-12 with boring SB-01-2002. This intermittent zone of organics may be a soil horizon marking land surface exposed during the sea level low-stand prior to the marine transgression and sea-level rise that continues today. The lack of a broad soil horizon is likely related to the erosion and re-working of the sediment during this marine transgression.

In addition, limited areas of Horseshoe Shoal contained near-surface gaseous sediments derived from organic material which was identified by acoustical penetration restrictions during the geotechnical seismic profiling. This is a common occurrence in shallow near-shore sediments. Signs of high biogenic gas content, such as sea-bed pockmarks, were not identified during the geophysical surveys.

In addition to the organic soil horizon, a thin but distinct sedimentary facies of interbedded clay was locally observed at the same location and others, but at a greater depth. Though not widespread, this may be evidence of a former glacial lake. Analysis of the sub-bottom geophysical results and the deep boring data indicates this intermittent clay horizon has been eroded, a geologic unconformity. This is best illustrated on the cross section presented in Figure 4.1.1-13 comparing the silty-clay horizon of SB-03 and the fine sand and clay horizon of SB-02-2002, with the sandy sediment in SB-01.

A correlation between the geophysical and geotechnical soil boring results indicates the subsurface sediment is dominated by fine to coarse-grained sand interbedded with deposits of clay, silt, gravel and/or cobbles. An example of this geologic setting is illustrated on the geophysical trackline profile G-13, correlated to marine boring GZA-SB-02 in Figure 4.1.1-15.

Evidence of diapirism, a fairly common type of soft sediment deformation in continental shelf sediments, was assessed for the area of the proposed action. Diapirs can be composed of salt or mud depending on the source sediments. Sediments undergo compaction as younger sediments are deposited over them, leading to increasing pressure on fluids within the sediments. The pressurized fluids can start to flow, mobilizing the sediments to zones of lower pressure at or near the seafloor. This process may also be associated with methane-producing organic content in the sediments (Kennett and Fackler-Adams, 2000).

In the process of flowing upward, the diapirs deform the overlying sediments in a doming or piercing fashion. Diapirs are discrete features that can be identified on geophysical subbottom profiler data and can be avoided. They can be active or inactive, exhibit a range of sizes, and may or may not intersect the seafloor.

Researchers reviewing geophysical data collected on outer continental shelf-upper continental slope margins around the world, including along the U.S. Mid Atlantic outer continental margin, have observed a number of features that may be caused by the release to the seafloor of pressurized subsurface fluids, possibly coupled with pore gas in the sediments (Hill et al., 2004). Water/gas expulsion from sediments can cause pockmarked depressions in the seafloor, and slumping and landslides of fine-grained marine sediments in areas of steep unstable slopes (such as on continental slopes in deep water). Potential large-scale mass wasting of marine sediments on continental slopes has been speculated to trigger tsunamis, though few have been reported throughout the world (Driscoll et al., 2000).

A review of geologic literature did not result in evidence of salt or methane hydrate diapirism in Nantucket Sound.

Some small nearshore features have been interpreted as sediment diapirs in western Nantucket Sound (Swift, 2006) and a possible diapir is also exposed along the eroding cliffs along the Outer Cape (Oldale et al., 1993).

In addition, limited evidence of mud diapirism deforming sediment in Nantucket Sound, outside of the area of the proposed action in Waquoit Bay, is available in geologic literature. The processes that control the nature and extent of these geologic features are not well understood. Researchers further speculate that mud diapirism may be widespread beneath land and the seafloor of Nantucket Sound. In the Waquoit Bay area, at least one diapir appears to be actively deforming the seafloor upward in a region of active tidal sediment transport. The study suggests that the presence of such features in Nantucket Sound may present a hazard to permanent offshore structures emplaced in the area (Swift, S. A. and Mulligan, A., 2003).

No evidence of diapirism has been identified to date in the Nantucket Sound areas surveyed for the proposed action, based upon the review of the shallow and deep subbottom profiler records completed for the proposed action (TRC, 2007).

The area of the proposed action is on the shallow inner continental shelf, approximately 125 miles (200 km) landward of the deep-water outermost continental shelf and upper slope margin, where the mass sediment slumps and the possible water/gas expulsion features have been observed along the eastern United States coast. Although the proposed action is located on the low-relief topographic high that is Horseshoe Shoal, slopes are gradual and the potential for mass wasting of sediments along the shoal's edges is low. Nonetheless, the presence/absence of diapirs and shallow gaseous sediments, as well as slope stability, would be evaluated within the proposed action's Area of Potential Effects (APEs) during the shallow hazards survey and the supplemental post-lease geotechnical program.

Bedrock was not encountered during the geophysical investigation. The depth to bedrock beneath the seafloor is estimated at greater than 300 to 900 ft (91.5 to 274.4 m) below the seafloor across the area of the proposed action, sloping to the southeast. The estimated depth to bedrock is below the deepest foundation proposed (USGS, 1983; USGS, 1990; USGS, 2006d).

#### 4.1.1.2.3 Onshore Geology

The two 115 kV AC submarine transmission cables are proposed for landfall at the end of New Hampshire Avenue in the Town of Yarmouth. From this landfall, an onshore 115 kV transmission cable system would be installed in an underground conduit system within existing roadways for approximately 4.0 miles (6.4 km) until it intersects the existing NSTAR Electric transmission line ROW at Willow Street in Yarmouth. From that point, the onshore transmission cable system would proceed west, and then south in an underground conduit system approximately 1.9 miles (3.1 km) along the existing NSTAR Electric ROW to the Barnstable Switching Station. See Figure 4.1.1-16 which illustrates the onshore cable route and anthropogenic features.

The overland run, from landfall to just before Willow Street, is located beneath an existing roadway over thick Harwich Outwash Plain deposits, see Figure 4.1.1-16. The Harwich Outwash Plain consists of unconsolidated sand and gravel, with localized silt and clay (USGS, 2006a). From that point to the Barnstable Switching Station, the transmission corridor traverses the Sandwich Moraine along existing roadway, then an existing utility ROW. The Sandwich Moraine contains thick unconsolidated, poorly-sorted, sand, silt, and clay, and includes cobbles and boulders (USGS, 2006a).

To further evaluate the subsurface conditions along the onshore cable route, four borings and three test pits were completed. Below the shallow fill material, where present, unconsolidated glacial sediments were penetrated along the entire onshore cable route including the fluvial outwash sediments on the Harwich Outwash Plain, and the unstratified glacial sediments on the Sandwich Moraine. Bedrock was not encountered.

To illustrate the materials encountered and relative increase in topography from landfall, through the Harwich Outwash Plain, and along the Sandwich Moraine, two cross sections were completed. Cross section D-D′, completed from four soil borings advance in existing roadways from landfall to the mid-Cape Highway is presented on Figure 4.1.1-17 (plan view of the cross section locations are presented on Figure 4.1.1-16). Cross section D′-D″, completed from three test pits advanced within the existing utility ROW, runs from the mid-Cape Highway to the Barnstable Switching Station is presented on Figure 4.1.1-18.

#### *4.1.1.3 Seismic Setting*

In general, Cape Cod and Nantucket Sound are considered a relatively stable tectonic setting, distantly located from a tectonic plate boundary, where frequent high energy earthquakes are typically more common. This intraplate setting is not a seismic-free location. The seismic activity here is less frequent than at plate boundaries, but low intensity earthquakes are common in New England, with an average of 30 to 40 occurring each year, but with most never felt by residents. In Massachusetts, 316 earthquakes were recorded between 1627 and 1989. In Rhode Island, only 32 earthquakes were recorded between 1766 and 1989 (NESEC, 2006).

Compared to the mainland of New England, it is recognized that Nantucket Sound is relatively less seismically active. However, on October 24, 1965, the residents of Nantucket Island felt a moderate earthquake. Very slight damage was recorded, mostly to ornaments and doors. Windows and dishes rattled, and house timbers creaked (USGS, 2006b). This recent example indicates that the area of the proposed action is not earthquake free but that seismic activity is low energy.

Occasionally, higher energy earthquakes could occur in Massachusetts, such as the largest earthquake recorded in Massachusetts, the Cape Ann earthquake of 1755. With an intensity value of VIII on the Modified Mercalli scale (magnitude 6+ on the Richter Scale), very strong shaking and moderate structural damage were recorded in Boston and the North Shore (USGS, 2006b).

Seismic waves travel out from an earthquake epicenter through the surrounding rock. Ground motion is higher closer to the location of the event. In general, ground motion decreases away from the epicenter, though the amount of ground motion at the surface is related to more than just distance from the epicenter. Some natural materials can amplify ground motion, for instance ground motion is generally less on solid bedrock and greater on thick deposits of clay, sand, or artificial fill.

Seismic hazards defined in building codes are typically based on peak ground acceleration. During an earthquake, a particle attached to the earth would move back and forth irregularly. The horizontal force a structure must withstand during an earthquake is related to ground acceleration. Peak ground acceleration is the maximum acceleration experienced by a particle during an earthquake.

The USGS produces probabilistic Seismic Hazard Maps for the United States with peak ground acceleration values represented as a factor of "g." One g is equal to the force on an object at the surface of the earth due to gravity. Engineers utilize these probabilistic ground motion values, representing hard rock beneath site soils, when designing earthquake resistant structures.

The USGS Seismic Hazard Maps were reviewed for the area of the proposed action. The maps show a 10 percent probability of a 2-3 percent g exceedence in 50 years (see Figure 4.1.1-19). In addition, there is a 2 percent probability of a 6 to 10 percent g exceedence in 50 years (see Figure 4.1.1-20) (USGS, 2002a).

#### 4.1.1.3.1 Liquefaction

Liquefaction is a process whereby the strength and stiffness of a soil and/or sediment is reduced by earthquake shaking or other rapid loading. The result is a transformation of soil and/or sediment to a liquid state. Typically, three general factors are necessary for liquefaction to occur. They are (USGS, 2006c):

- Young (Pleistocene) sands and silts with very low or no clay, naturally deposited (beach, river deposits, windblown deposits) or man-made land (hydraulic fill, backfill).
- Soils and sediments must be saturated. The space between individual particles is completely filled with water. This water exerts a pressure on the soil and sediment particles that influences how tightly the particles themselves are pressed together. This is most commonly observed at or near bodies of water such as rivers, lakes, bays, and oceans, and associated wetlands.
- Severe shaking. This is most commonly caused by a large earthquake. Prior to an earthquake, the water pressure is relatively low. However, earthquake shaking can cause the water pressure to increase to the point where the soil particles can readily move with respect to each other. This factor is limited by the distance from the large earthquake epicenter. That is, liquefaction potential decreases as distance increases from the epicenter of a large earthquake.

Based on the USGS Seismic Hazard Maps for the area of the proposed action, the risk of a large earthquake resulting in severe shaking of the young, saturated sand deposits of Horseshoe Shoal is low. Site specific assessments would be completed following completion of the permitting process.

#### 4.1.1.3.2 Faults

A fault is a fracture surface within the Earth's lithosphere along which displacement has occurred. No active (younger than about 10,000 years) shallow or deep faults have been identified within the area of the proposed action based upon geologic literature review. Older in-active faults, including those likely associated with what is believed to be a nearby failed Triassic-Jurassic rift basin, are likely present in the area (see possible evidence of the failed rift via the basalt found at approximately 1,400 ft [426.8 m] below ground surface in boring USGS, 6001 on Figure 4.1.1-6).

### 4.1.2 Noise

Noise could affect the local environment during the construction, operation and decommissioning of the proposed action. The ambient sound level of a region is defined by the total noise generated within the specific environment, and is usually comprised of sound emanating from natural and artificial sources. At any location, both the magnitude and frequency of environmental noise may vary considerably over the course of the day and throughout the week. A noise assessment was performed based on the collection of background sound levels and comparing them to the various noises that would be produced during project construction, operation, and decommissioning.

#### *4.1.2.1 General Information on Noise*

##### 4.1.2.1.1 Above Water Noise

Sound results from vibrations in the air. The range of pressures that cause the vibrations that create sound is large. Sound is therefore measured on a logarithmic scale, expressed in decibels (dB). The frequency of a sound is the "pitch" (high or low). The unit for frequency is hertz (Hz). Most sounds are composed of a composite of frequencies. The normal human ear can usually distinguish frequencies from 20 Hz (low frequency) to about 20,000 Hz (high frequency), although people are most sensitive to frequencies between 500 and 4000 Hz. The individual frequency bands can be combined into one overall dB level.

When sound energy is concentrated at a single frequency, the peak in the spectrum may be audible as a "pure tone." Generally this condition occurs when a particular 1/3-octave band has a sound level higher than the average level of the two adjacent bands by 5 to 15 dB (with the 15 dB threshold used for low frequencies below 125 Hz). This is the definition of a pure tone condition that was used in this analysis.

Sound is typically measured on the A-weighted scale (dBA). The dBA has been shown to provide a good correlation with the human response to sound and is the most widely used descriptor for community noise assessments (Harris, 1991). The lowest sound that is usually found in rural environments is about 30 dBA, while an uncomfortably loud sound is about 120 dBA. In order to provide a frame of reference, some common sound levels are provided in Table 4.1.2-1 (all Tables are in Appendix A).

Common terms used in this noise analysis are defined as follows:

**$L_{eq}$** – The equivalent noise level over a given period. It is a single value of sound that includes all of the varying sound energy in a given duration.

**$L_{90}$** – The dBA sound level exceeded 90 percent of the time, and is always less than the $L_{eq}$. The $L_{90}$ is utilized by the MassDEP to characterize the background or residual noise level. This descriptor generally excludes extraneous intrusive sounds such as an aircraft overflight or occasional vehicular traffic.

**$L_{max}$** – The near instantaneous maximum sound level measured during a given period. It is therefore always greater than the $L_{eq}$.

Two measures often used by Federal agencies to relate the time-varying quality of environmental noise to its known effect on people are the 24-hour equivalent sound level ($L_{eq(24)}$) and the day-night sound level ($L_{dn}$). The $L_{eq(24)}$ is the level of steady sound with the same total (equivalent) energy as the time-varying sound of interest, averaged over a 24-hour period. The $L_{dn}$ takes into account the duration and time the noise is encountered. The $L_{dn}$ is the $L_{eq(24)}$ with 10 dB on the dBA added to nighttime sound levels between the hours of 10 p.m. and 7 a.m., to account for people's greater sensitivity to sound during nighttime hours.

##### 4.1.2.1.2 Below Water Noise

Similar to above water noise, in the underwater environment, acoustic energy moves through the water as sound waves, which are minute variations in water pressure. The main difference is the medium in which the sound vibrations pass through (water instead of air). The underwater sound pressure level is defined on a dB scale, similar to the familiar above water decibel scale, but the reference pressure is different. As a result, an identical sound pressure wave in air and underwater is recorded differently in the two fluids. For example, a sound pressure of 80 dB in air is equivalent to 106 dB underwater, i.e., the underwater scale is shifted 26 dB higher than the air scale. There are also substantial differences in ambient (background) sound levels in air and in the ocean, and in the frequency weighting that is used in water versus air. Thus, the reader should not try to equate dB levels reported for water with those in air, or vice-versa.

The existing sound in the sea comes from many sources, natural and man-made, including turbulence in ocean currents, tides, surface waves, cavitations (collapse of air bubbles) in near-surface waves, low-level seismic activity, sea animals, and ship traffic. The hearing capabilities of and the frequency responses of marine mammals vary widely. Therefore, underwater sound levels are presented as un-weighted or linear decibels (dBL). As with airborne sound, the frequency component of the underwater sound is important in this analysis.

Underwater sound levels are commonly measured as either the $L_{eq}$ or the $L_{max}$. For underwater sound, the typical measurement range at sea is from 80 dB (still water conditions) to 180 dB. The ambient underwater sound level is highly variable in time and by location. For example, a one-knot current can produce turbulent pressure changes (sound waves) of 116 dB. Typical ambient underwater sound levels in Nantucket Sound are from $L_{eq}$ 95 to 115 dB for surface winds of 5 to 30 mph (2.2 to 13.4 m/s).

#### *4.1.2.2 Regulatory Requirements*

In 1974, the USEPA published, *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety*. This publication evaluates the effects of environmental noise with respect to health and safety. The document provides information for state and local governments to use in developing their own ambient noise standards. The USEPA has determined that to protect the public from activity interference and annoyance outdoors in residential areas, noise levels should not exceed an $L_{dn}$ of 55 dBA.

The MassDEP has a noise standard (310 CMR 7.10). Although the proposed action would be located outside of the Massachusetts territorial limit (3.5 miles [5.6 km] from shore), and the standard would not technically be applicable to the proposed action, the Secretary of the EOEA included a requirement in the MEPA Certificate that required that the standard be addressed for informational purposes.

Noise is regulated in the Commonwealth of Massachusetts under regulation 310 CMR 7.10. The regulation limits sound as follows:

(1) No person owning, leasing, or controlling a source of sound shall willfully, negligently, or through failure to provide necessary equipment, service, or maintenance or to take necessary precautions cause, suffer, allow, or permit unnecessary emissions from said source of sound that may cause noise.

This "Noise" definition is described quantitatively in MassDEP Noise Policy 90-001 as follows:

- Increases in broadband sound may not exceed 10 dBA above ambient at the property line and nearest residence.
- A source may not produce a "pure tone" condition. A pure tone is defined as any octave band center frequency sound pressure level that exceeds the two adjacent center frequency sound pressure levels by 3 dB or more.

These criteria are applied both at the property line and at the nearest inhabited residence. Ambient sound is defined as the background dBA sound level exceeded 90 percent of the time ($L_{90}$). This type of measurement essentially excludes short term, intrusive noise sources, such as aircraft overflights or occasional traffic. The MassDEP standard does not apply to construction activities. There are no local or Federal noise standards applicable to the proposed action.

### *4.1.2.3 Existing Conditions*

#### 4.1.2.3.1 Offshore Locations

Ambient noise monitoring programs were conducted at two offshore locations, near navigation buoys where recreational boaters travel: at Buoy G5 in the North Shipping Channel about 1 mile (1.6 km) north of the edge of the Proposed Alternative location of the proposed action, and at Buoy R20 at the edge of the Main Channel about 1/3 mile (0.5 km) south of the Proposed Alternative location (Report No. 4.1.2-1). These data were collected on October 22, 2002 between 10 a.m. and 12 noon. The weather conditions were clear skies, light winds (4 mph [1.8 m/s] average), and light seas (0.5 to 1.5 ft [0.15 to 0.46 m] waves). The boat engine was shut-off during the measurements and the dominant sounds were wave interaction with the boat hull (the boat was allowed to drift), periodic over flying aircraft and distant boat traffic. Figure 4.1.2-1 is a map showing the locations of Buoys G5 and R20, as well as all onshore monitoring locations and modeling receptors.

The background ($L_{90}$) sound levels were 35 and 37 dBA, respectively, at Buoys G5 and R20. The corresponding average ($L_{eq}$) sound levels were 46 and 51 dBA. To estimate existing average sound levels for the design wind speed condition of the proposed action, the measured levels were increased by 14 dBA, the average observed difference between the two wind conditions for long term monitoring done at three shoreline locations (see Section 4.1.2.3.2 of this document). The frequency spectrum for existing condition sound levels at the two buoy locations are given in Figure 4.1.2-2.

#### 4.1.2.3.2 Onshore Locations

Baseline sound monitoring locations were chosen to satisfy the MEPA certificate that required monitoring at "the nearest representative locations along the south coast of Barnstable and Yarmouth and the east coast of the Vineyard." Along the coasts, there is a wide variety of existing land use and population density. If representative locations were targeted at areas with the most people, then logical choices would be Hyannisport, the shore along Lewis Bay in Yarmouth and Edgartown harbor. These areas, however, have high levels of human activity and motor vehicle traffic, and baseline sound levels are higher than those found at uninhabited areas along the coast. To ensure the measured sound levels are a conservative (i.e., low) estimate of baseline conditions along the entire coast, secluded areas along the coast were sought out (Report No. 4.1.2-1). In the same vein, measurements were taken in November and December 2002, a time of year with little or no beach traffic (cars, trucks and boats). Measurements made in the summer would have been higher. The three monitoring sites were located on the coast at Point Gammon in Yarmouth (5.2 miles [8.37 km]) from the closest WTG at the northeast corner of the Proposed Alternative location of the proposed action), at Oregon Beach, Cotuit in Barnstable (5.5 miles

[8.9 km]) from the closest WTG at the northwest corner of the Proposed Alternative location of the proposed action), and at Cape Poge Wildlife Refuge at the tip of Cape Poge on Martha's Vineyard (5.4 miles [8.7 km]) from the closest WTG at the southwest corner of the Proposed Alternative location of the proposed action).

Point Gammon is on a private peninsula (Great Island) in Yarmouth that sticks out into Nantucket Sound. The monitoring location was above a south-facing beach on the south tip of Great Island. The equipment was located 100 ft (30.5 m) from the high water mark where the grade is 20 ft (6.1 m) above the beach. The microphone (with wind screen) was mounted 7 ft (2.1 m) above grade. The principal sounds at this site were the wind and ocean waves, periodic over-flying aircraft, and an occasional passing ferryboat. There was no vehicle or pedestrian access to this location during the measurement program that lasted seven days (November 15 - 22, 2002).

Oregon Beach is a public beach located off Main Street and Oregon Way, south of Cotuit Center in Barnstable. The coast generally faces southeast at this point on the Cape. The equipment was located 80 ft (24.4 m) from the high water mark where the grade is a few feet above the beach. The microphone (with wind screen) was mounted 7 ft (2.1 m) above grade. The principal sounds at this site were the wind and ocean waves, sea birds, periodic over-flying aircraft, and occasional motor vehicles and pedestrians accessing the beach area. Monitoring lasted more than four days (November 14 - 18, 2002).

Cape Poge Wildlife Refuge on Chappaquiddick Island, Martha's Vineyard is a wildlife refuge and recreational area with facilities for swimming and shore fishing. It is a very isolated location, travel to which requires a four-wheel drive vehicle. The coast faces east towards the ocean at the monitoring location that was setup near the lighthouse above the beach. The equipment was located 40 ft (12.2 m) from the high water mark on a sand dune where the grade is 20 ft (6.1 m) above the ocean. The microphone (with wind screen) was mounted 8 ft (2.4 m) above grade. The principal sounds at this site were the wind and ocean waves, and sea birds. Measurements were taken for seven days (November 25 - December 2, 2002).

The baseline measurements of existing sound conditions were examined in detail for the two wind conditions for which the proposed action's acoustic effects were quantified in Section 5.3.1.2 of this document: the cut-in wind speed of the WTGs (a steady wind speed of 8 mph at hub height, equivalent to 5 mph at 9.8 ft [3 m] above the ground) and the design wind speed of the WTGs (a steady wind speed of 30 mph [13.4 m/s] at hub height, equivalent to 16 [7.2 m/s] mph at 9.8 ft [3 m] above the ground). The WTGs would not operate under hub height wind speeds below 8 mph (3.6 m/s).

Background ($L_{90}$) and average ($L_{eq}$) sound level measurements are summarized for three separate meteorological conditions in Table 4.1.2-2: (1) the cut-in wind speed for the turbines; (2) the design wind speed for the turbines (on-shore flow); and (3) the design wind speed for the turbines (off-shore flow). The distinction between on-and off-shore winds at the design wind speed condition is important for two reasons: (1) baseline sound levels are lower for off-shore winds as discussed below; and (2) sound from the proposed action would be reduced by 27 dBA under off-shore winds due to the wind shadow effect. The frequency spectrums for these measurements are given in Figures 4.1.2-3 through 4.1.2-11.

The baseline measurements of existing sound conditions covered a full range of meteorological conditions from calm to high winds, with wind directions blowing both onshore and offshore and average wind speeds of 0 to 28 mph (0 to 12.5 m/s). The monitoring equipment was located on elevated land above and back from the high water mark to minimize the influence of surf sound yet still provide a quiet environment removed from highway and street noise. Surf sound is not an important factor except under high wind conditions, when surf sound can be heard anywhere along the coast. The baseline measurements, summarized in Table 4.1.2-2, reveal background ($L_{90}$) sound levels as low as 27 dBA (at

Point Gammon) and in the 30s at the other two sites, which are representative of very quiet rural areas. Since the measurements also covered periods of time when steady winds were up to 28 mph (12.5 m/s) (wind gusts were higher), higher baseline sound levels are expected, and these higher levels would be measured at any location, whether it was along the shore where there might be surf sound in the background or inland where noise from wind flow around buildings and trees occurs.

At Point Gammon (November 15 - 22), measured background ($L_{90}$) levels ranged from 27 to 66 dBA, and average ($L_{eq}$) levels were 35 to 71 dBA. At Oregon Beach (November 14 - 18), measured background ($L_{90}$) levels ranged from 34 to 57 dBA, and average ($L_{eq}$) levels were 41 to 61 dBA. At Cape Poge (November 25 - December 2), measured background ($L_{90}$) levels ranged from 37 to 70 dBA, and average ($L_{eq}$) levels were from 40 to 73 dBA. At all three sites, existing sound levels are directly correlated to surface wind speed, and on-shore winds produce slightly higher sound levels than offshore winds, which is expected because offshore winds both suppress wave action at the shoreline and shield the coast from the sound of ocean waves by the wind shadow effect.

The long term monitoring conducted demonstrated also that ambient sound levels increase with increases in wind speed. On average, ambient sound levels during the design wind speed were 14 dBA greater than during the cut-in speed.

#### 4.1.2.3.3 Underwater Noise Levels

Short-term noise level measurements were collected of underwater noise at Buoy G5 in the North Shipping Channel and at Buoy R20 at the edge of the Main Channel. Measurements were conducted on October 22, 2002 between the hours of 10 a.m. and 12 noon. Meteorological conditions included clear skies, light winds averaging 4 mph (1.8 m/s) and light seas (0.5 to 1.5 ft [0.15 to 0.46 m] waves), which are conservative conditions (e.g., lower underwater noise levels would be expected under these types of meteorological conditions). The boat engine was shut off during the measurements. The dominant noise sources were the wave interaction with the boat hull, aircraft, and distant boat traffic.

Measured $L_{eq}$ underwater sound levels were found to be 90 dB and 93 dB at Buoys G5 and R20, respectively. The sound level at Buoy R20 is slightly higher due to the shallower water and greater current. The depth at this location is also more representative of the water depth on Horseshoe Shoal, and accordingly, the Buoy R20 data were used as a baseline for the proposed action.

Underwater sound levels with higher wind speeds (as would occur with proposed action operation) would be higher. Studies conducted in other coastal water areas indicate that the sound level increases 7.2 dB per doubling of wind speed. Accordingly, the estimated underwater $L_{eq}$ sound level for the design wind speed of the proposed action would be 107.2 dB. The frequency spectrum for the existing condition is provided in Figure 4.1.2-12.

The applicant further reviewed baseline underwater sound level measurements conducted over a 9-month period at the North Hoyle, United Kingdom wind farm site. Shoal depths at this location are similar to those at the site of the proposed action. This long term monitoring program revealed that underwater sound levels are nearly constant regardless of the time of day, with the exception of some peaks during midday hours caused by passing boat traffic. Measured baseline levels at the North Hoyle site were in the range of 100 to 150 dB. The 90 to 93 dB sound levels measured at the site of the proposed action are therefore relatively low compared to the measured North Hoyle site, even when scaled up to 107.2 dBA to account for the design wind speed condition. The short term measurements conducted at the site of the proposed action are considered to be adequate to characterize the existing underwater noise environment at the site of the proposed action.

### 4.1.3 Physical Oceanography

This section provides a characterization of existing conditions for currents, waves, salinity, temperature, sediment transport, and water depth/bathymetry in Nantucket Sound. These same parameters are also discussed for Lewis Bay.

#### *4.1.3.1 Existing Conditions*

The proposed action is located within Nantucket Sound, with electric transmission cable installation continuing into the waters of Lewis Bay on the south shore of Cape Cod. Nantucket Sound is a broad passage of water that separates the south shore of the Cape Cod mainland and the islands of Nantucket and Martha's Vineyard. It is approximately 23 miles (37 km) long (east-west direction), and between 6 and 22 miles (9.7 and 35.4 km) wide. The Sound has depths up to 70 ft (21.3 m) below MLLW. The depths relative to MLLW shallow up to 2 ft (0.6 m) on Horseshoe Shoal. WTGs that have a diameter of 16.75 ft (5.1 m) would be set in water depths ranging from 12 to 39 ft (3.6 to 12 m), while WTGs with a diameter of 18 ft (5.5 m) would be set in water depths ranging from 40 to 50 ft (12.2 to 15.2 m). The spacing between the WTGs is proposed to be 0.39 mile (0.63 km) in a northwest/southeast direction and 0.62 mile (1 km) in an east/west direction. The Horseshoe Shoal area is a dynamic system with strong tidal currents (1.6 to 3.1 ft/s [0.5 to 1.0 m/s]) and shifting bed forms consisting mainly of sand. The Sound's tide range is approximately 3 ft (0.9 m). Lewis Bay is a coastal embayment along the south coastline of Cape Cod. It is northeast of Hyannis Harbor, and is separated from Nantucket Sound by Point Gammon and Great Island. Oceanographic conditions for each area are discussed in the sections that follow.

##### 4.1.3.1.1 Currents and Tides

An empirical analysis based on current Acoustic Doppler Current Profiler (ADCP) data and historical data was used to determine tidal current speeds and direction for the site of the proposed action; and modeling by Woods Hole Group (Trowbridge, 2002 as referenced in Report No. 4.1.1-9) was used to determine wind-driven currents on Horseshoe Shoal.

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, however, the southwesterly winds during the summer produce eastward flow through Nantucket Sound (Wilkin, 2006). 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 1 to 4 ft (0.3 to 1.2 m), with tidal surges of up to approximately 10 ft (3 m) having been recorded during hurricanes (Bumpus et al., 1973; Gordon and Spaulding, 1979). Times of high and low tides vary across the Sound by up to two hours.

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 (Goud and Aubrey, 1985). Tides around the Nantucket Shoals produce a strong anticyclonic circulation (Wilkin, 2006). The tidal current flows to the east during the flood tide (incoming) and to the west during the ebb tide (outgoing). Higher speeds occur between islands with a relatively uniform speed (1 knot [0.5 m/s]) in the Sound, although speeds and directions vary as bathymetry changes. Speeds on Horseshoe Shoal range higher, up to 2 knots (1 m/s). Nearing shore, the speeds reduce and directions are oriented by local bathymetry or shorelines (Report No. 4.1.1-2). 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 ft (200 $m^2$) per tidal cycle, or roughly five percent of the total easterly and westerly tidal flows (Bumpus et al., 1971).

To characterize site-specific tidal and wind-driven currents at the site of the proposed action in Nantucket Sound, analytical models were applied by the applicant, with the results summarized as follows.

- Flood currents on the shoals are generally directed easterly, with ebb currents generally directed westerly. The average direction of the ebb current was 230 degrees with average speeds between 0.6 and 1.9 knots (0.31 and 0.98 m/s), and the average direction of the flood current was 50 degrees with average speeds between 0.6 and 1.2 knots (0.31 and 0.62 m/s).
- 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 percent stronger than mean tidal currents.
- Tidal current velocities were calculated to be approximately 1.2 knots (0.61 m/s) 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.
- Current speed and direction were found to vary more with location than water depth.

The tide range in Lewis Bay is 3 ft (0.9 m) with no variation in range. The tidal currents are highly variable in Lewis Bay although typically weak. At the cable landfall location the currents are very weak, less than 0.05 knots (0.03 m/s) during both maximum flood and ebb. At the location west of Egg Island the maximum speed is between 0.30 and 0.35 knots (0.15 and 0.18 m/s) during ebb.

#### 4.1.3.1.2 Waves

There is no extensive source of wave data within Nantucket Sound, so available wind data and wave data taken from ADCP devices deployed between May 2003 and September 2004 were used to characterize wind-generated waves at the site of the proposed action (Report No. 4.1.3-1). The major factors affecting the magnitude and period of wind-generated waves in this area are: the fetch length (the distance over which wind acts on the water surface), average water depth, and wind speed. The wave model applied used these factors to estimate wave height and period under different conditions. Fundamentally, larger waves are generated as wind speed, water depth, and fetch length increase. Fetch is restricted within Nantucket Sound due to surrounding landforms including Cape Cod, Monomoy Island, Nantucket Island, and Martha's Vineyard.

Wave model simulations were performed using the USACE's *Wind Speed Adjustment and Wave Growth* model (USACE, 1992) to estimate significant wave height (i.e., the average height of the highest 1/3 of waves in a sea state); peak period (i.e., the period that characterizes the majority of the waves in the sea state); and peak direction. The results represent wave conditions near the center of the proposed action at Horseshoe Shoal. Generally, the model indicates that Horseshoe Shoal is exposed to the largest waves from the easterly directions. Wind-generated significant wave heights generally range from less than 1 to nearly 4 ft (0.3 to 1.2 m), with relatively short spectral peak wave periods (between 2 and 4 seconds). Individual wave heights can be higher, and substantially higher waves would be present during storms.

Using the model results, a shoaling coefficient and wave breaking criteria were applied to obtain a distribution of the wave heights over the shoals. Generally, wave height changes in the shallow portions of the shoal due to wave shoaling and breaking, while wave period remains constant. Figure 4.1.3-1 shows the significant wave height distribution for the largest calculated significant wave height at the site of the proposed action.

It is also possible that longer period waves enter Nantucket Sound from the Atlantic Ocean. Therefore, a conservative estimate of long period swell conditions was developed for the site of the proposed action. The average wave height of offshore waves approaching from easterly through southeasterly directions east of Monomoy within the Atlantic Ocean was used for this analysis. The average height for these offshore waves is 4.5 ft (1.4 m), and the average wave period is eight seconds. Average ocean waves were selected for this analysis to capture potential effects for longer period waves. Although significantly higher and longer period waves occur in the ocean (e.g., heights greater than 20 ft [6.1 m] with periods exceeding 12 seconds), it was not judged appropriate to assume such large waves occur in Nantucket Sound given the presence of the numerous relatively shallow shoals. A shoaling coefficient was used to modify the ocean swell and provide an estimate of resulting wave heights and distribution at Horseshoe Shoal. Offshore waves are also likely to be modified substantially by the complex and shallow shoal structure separating Nantucket Sound from the Atlantic Ocean, as well as by the relatively narrow gaps between Monomoy Island and Nantucket Island to the east and between Nantucket Island and Martha’s Vineyard to the south. These factors were not included in the analysis because these features would typically serve to dissipate ocean swell effects. Therefore, the analysis is relatively conservative, reflecting higher wave levels than would likely occur. The results are shown in Figure 4.1.3-1.

External analysis was performed to estimate wave height and period characteristics for the 2-, 10-, 50- and 100-year return periods. These were estimated for both locally generated and offshore waves using a computer model entitled “Extrm2: Extremes Program.” The extreme storm wave for the proposed action is defined as the average height of the highest 1 percent of all waves in the spectrum (for the 50-year return the extreme storm wave at Horseshoe Shoal was estimated to be 17.3 ft (5.3 m).

Data was collected at the SMDS tower between April 2003 and September 2004 using an ADCP. The wave data indicated that the maximum recorded significant wave height reached 6.6 ft (2.0 m) while the maximum wave height reached 8.2 ft (2.5 m). The majority of wave patterns had a significant wave height between 1 ft (0.3 m) and 1.3 ft (0.4 m). The wave period varied depending on whether wind-generated waves (2 to 6 second periods) or swell (6 to 12.8 seconds) determined the shape of an individual wave spectrum. The highest waves had periods of approximately six seconds, slightly longer (about one second longer) than periods predicted by wave modeling.

Waves having periods between 2.6 and 3.4 seconds were the most frequently recorded in the data set. The long-period portion of the histogram reveals a subtle maximum in wave period distribution at periods of about seven seconds. This suggests that many of the swell ‘cases’ did not represent distinctive swell waves but were rather a result of noise in the data. Swell amplitudes were higher for the periods of time of high water, suggesting that the probability of swell penetration in the Sound increases as the sea level increases.

Typically, winds with speeds of 8.8 knots (15 m/s) generated waves with a significant wave height of 3.9 ± 0.7 ft (1.2 ± 0.2 m). This relationship varied slightly, depending on water depth. Measured waves were approximately ten percent higher during the periods of high water. A comparison with model results indicates that the observed wave height/wind speed relationship fits well with the results of the model. Wind and wave directions correlated well with a tendency for waves to propagate along the east-west axis of Nantucket Sound.

#### 4.1.3.1.3 Salinity

Salinities in Nantucket Sound are near oceanic, and salinity gradients are small due to strong lateral and vertical mixing. River runoff into Nantucket Sound is low, so there is little dilution of ocean waters with fresh water. Surface and bottom water salinities vary seasonally and spatially from about 30 parts per thousand (ppt) to 32.5 ppt (Bumpus et al., 1973). Surface water salinities throughout the Sound are just over 31 ppt during the summer, and are uniformly about 32 ppt in the winter (Limeburner et al., 1980).

#### 4.1.3.1.4 Temperature

The annual cycle of surface and bottom water temperatures in Nantucket Sound encompasses a range of about 45ºF (7.2ºC), from nearly 30°F (-1ºC) in the winter to as high as 75ºF (24ºC) in the late summer (Bumpus et al., 1973). During ADCP data collection at the SMDS between April 2003 and September 2004, the recorded water temperature varied from 30.2°F (-1°C) (recorded in February) to 72.5ºF (22.5ºC) (recorded in August). Temperature extremes are greatest in coastal ponds and estuaries, and the seasonal temperature cycle is smallest in the deeper parts of the Sound. However, because the Sound is shallow and well mixed, there is little lateral temperature variation and vertical temperature stratification. There is a tendency in the summer for surface water temperature to increase from east to west in Nantucket Sound. In the winter, a slight gradient develops in the opposite direction (Limeburner et al., 1980). This change is caused by the intrusion of warmer continental shelf water into the Sound from the east during the summer months.

Bottom water temperature varies less and changes more slowly on a seasonal basis than surface water temperature. The highest bottom water temperature in Nantucket Sound during summer is in the range of 61ºF to 66ºF (16 to 19ºC) (Theroux and Wigley, 1998). Warmest bottom water temperatures are near the coast of the south shore of Cape Cod, and temperature decreases with distance offshore. Coolest bottom water temperatures in Nantucket Sound (during winter) are in the range of 32ºF to 35.6ºF (0 to 2ºC), and become warmer with distance from the Cape Cod and Nantucket shorelines.

#### 4.1.3.1.5 Sediment Transport

A comprehensive analytical two-dimensional sediment transport model developed by Woods Hole Group based on a theory by Madsen and Grant 1976 was used to conduct 26 simulations, addressing a range of current and wave conditions for the site of the proposed action. For each condition, the model calculated wave-induced bottom current velocities, near-bottom tidal current velocities, a qualitative representation of where and whether sediment transport would be likely to occur, and quantitative estimates of potential bed load, suspended load, and total sediment transport rates. The analytical sediment transport modeling was performed to determine the extent to which existing wave and current conditions are likely to lift and move sand at the site of the proposed action. Generally, the analysis found that active sediment transport occurs at all areas of Horseshoe Shoal, even under typical wave and tidal current conditions. The highest potential for sediment transport is along the shallow portions on the northwest corner, with little potential for sediment transport along the deeper east side of the shoal. The largest wind-generated waves in the wave distribution within Nantucket Sound can cause a significant increase in sediment transport.

Spring tidal currents initiate approximately 20 percent more transport than mean tidal currents, and wind-driven currents from a sustained 17.2 mph (7.7 m/s) westerly wind have a similar effect. The greatest impact on sediment transport initiation is due to waves. Larger locally generated waves within Nantucket Sound can cause a significant increase in sediment transport. If swell waves from the ocean impact the site at Horseshoe Shoal, sediment transport rates can increase as much as 100 fold, even for typical swell waves propagating from the Atlantic Ocean (e.g., 4 to 5 ft [1.2 to 1.5 m] height with an 8 second period). Since flood currents are stronger than ebb currents, there is a long-term forcing mechanism to cause the net transport of sediment to the east, particularly at Horseshoe Shoal.

Bed load transport (sediment movement along the sea bottom) on Horseshoe Shoal is typically an order of magnitude greater than suspended load transport. This is expected at the Horseshoe Shoal Site, where sediments are relatively coarse (Report No. 4.1.1-2). The level of wave and current energy under typical conditions is not sufficient to lift and suspend large volumes of sediment within the water column. The bed load flux on Horseshoe Shoal is between 0.18 and 25 cubic ft (0.005 and 0.7 $m^3$) per day.

The south central portion of Horseshoe Shoal is an area in which sand waves have been identified. Sand wave crests on Horseshoe Shoal were oriented in the north-south direction in general, with long period wavelengths ranging between 100 and 600 ft (30.5 and 183 m). Short period sand waves were located between the larger crests. Sand wave heights averaged 4 to 5 ft (1.2 to 1.5 m), but waves as tall as 15 ft (4.6 m) were found. The size of the sand waves is attributed to the dynamic shallow water environment on Horseshoe Shoal. The symmetry of the sand waves indicates a migration to the east or the west, depending on where they formed on Horseshoe Shoal. (USACE, 2004 as referenced in Report No. 4.1.1-3). Other areas of Horseshoe Shoal contain few significant topographical features and are dominated by smooth sandy bottoms (OSI, 2002).

The existing sediment transport in Lewis Bay is presented in Report No. 4.1.1-2 and Report No. 4.1.1-3. The bottom sediments are generally finer in Lewis Bay (up to 12 percent clays and silts) than in Nantucket Sound, consistent with the lower energy environment in the Bay. Lewis Bay is thus likely a depositional area which implies that the sediment transport is low since sediment would accumulate if there were sufficient sediment sources supplying material.

#### 4.1.3.1.6 Water Depth/Bathymetry

In general, the bathymetry in Nantucket Sound is irregular, with a large number of shoals present in various locations throughout this glacially formed basin. Charted water depths in the Sound range between 1 and 70 ft (0.3 and 21.3 m) at MLLW. A combination of NOAA nautical charts and project-specific hydrographic surveys were used to assess existing bathymetric conditions.

The site of the proposed action is located on Horseshoe Shoal, a prominent geological feature in the center of the Sound. Depths on Horseshoe Shoal have been mapped over the years as shallow as 0.5 ft (0.15 m) at MLLW, although this depth can vary from year to year. Measured depths of 60 ft (18.3 m) at MLLW occur between the northern and southern legs of the shoal. An east-west trending natural channel feature exists on the southern leg of the shoal, with measured water depths approaching 50 ft (15.2 m) at MLLW.

Water depths between Horseshoe Shoal and the Cape Cod shoreline are variable, with an average depth of approximately 15 to 20 ft (4.6 to 6.1 m) at MLLW. Along the transmission cable system corridor, depths vary from about 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 in Lewis Bay and Hyannis Harbor are variable, ranging from approximately 8 to 14 ft (2.4 to 4.3 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. There are three navigation channels in Lewis Bay: the

Federal Navigation Channel providing access to Hyannis Inner Harbor (authorized depth -13 ft [-4.0 m] MLLW); one privately maintained channel into Mill Creek (reported depth of -2 ft [-0.6 m] MLLW in 1983); and one privately maintained channel northeast of Great and Pine Islands (approximately 7 ft [2.1 m] deep at MLLW).

The submarine transmission cable system route would extend outside the eastern edge of the Federal channel into Lewis Bay, and would then turn east north of Egg Island to make landfall between Mill Creek and the privately maintained channel northeast of Great and Pine Islands. Water depths along this route in Lewis Bay range from 5 to 10 ft (1.5 to 4.6 m), with an average of approximately 10 ft (3 m). The shallowest portions of Lewis Bay/Hyannis Harbor along this route exist between Great Island and Dunbar Point and at the landfall, with depths of 1 to 4 ft (0.3 to 1.2 m) at MLLW.

### 4.1.4 Climate and Meteorology

This section describes the existing climate and meteorological conditions for the site. The Massachusetts climate is characterized by frequent and rapid changes in weather, large daily and annual temperature ranges, large variations from year to year, and geographic diversity. The National Climatic Data Center (NCDC), which is part of the NOAA defines distinct climatological divisions to represent areas that are, as nearly as possible, climatically homogeneous. Locations within the same climatic division are considered to share the same overall climatic features and influences. The site of the proposed action is located within the Massachusetts coastal division.

#### *4.1.4.1 Ambient Temperature*

The NCDC provided data that shows for the Massachusetts coastal division the average annual temperature is 49.8ºF (9.9ºC), the average winter (December - February) temperature is 30.9ºF (-0.6ºC), and the average summer (June through August) temperature is 69.0ºF (20.6ºC). The average daily maximum temperature in the coastal division is approximately 57.0ºF (13.9ºC) and the average daily minimum temperature is approximately 42.1ºF (5.6ºC) based on data collected in Hyannis, Massachusetts from 1971 through 2000. Average temperatures at the individual stations in the general area at or near the site are summarized in Table 4.1.4-1, along with the climatological division average where available. Data for some stations reflect different periods of record, but they show the lack of any major temperature differences in the area.

Table 4.1.4-2 provides information on the monthly ambient air temperatures within the Massachusetts coastal division. Data presented in Table 4.1.4-2 was collected at the Buzzard Bay Buoy Tower from 1985 through 2001 and is representative of the monthly temperature variations found in this climatological division.

#### *4.1.4.2 Wind Conditions*

Wind conditions in the Massachusetts coastal division have been summarized in Tables 4.1.4-3 and 4.1.4-4 using data collected at the Buzzard Bay Buoy Tower, which is located northwest of the Nantucket Sound, from 1985 through 2001. Table 4.1.4-3 presents the monthly and annual average wind speeds, monthly average peak wind gusts, and the maximum hourly peak wind gust recorded during this time period at the Buzzard Bay Buoy Tower and Table 4.1.4-4 presents the monthly and annual percent frequency of the wind directions recorded at the tower. The monthly average wind speeds range from a low of 13.7 mph (6.1 m/s) in August to a high of 20.4 mph (9.1 m/s) in December with an annual average of 17.3 mph (7.7 m/s). The average monthly peak wind gust was 22.9 mph (10.2 m/s) and the peak hour wind gust was recorded to be 88.8 mph (39.7 m/s). Wind directions are variable throughout the year as shown in Table 4.1.4-4; however, during the summer months (June through August) the predominant winds are from the southwest, while during the winter months (December through February) the predominant winds are from the northwest.

Mean wind speeds within the Nantucket Sound area, at the height of the proposed wind rotor height of 257 ft (78.3 m), were estimated using AWS Truewind's proprietary algorithm and vary from a low range of 15.7 to 16.8 mph (7 to 7.5 m/s) in the nearshore areas to a high range of 20.1 to 21.3 mph (9 to 9.5 m/s) in the southern and eastern portions of the Sound that lack the sheltering effects from the islands (see Figure 4.1.4-1). An average wind speed of 19.75 mph (8.8 m/s) was recorded at the Nantucket Sound meteorological tower over the three years of data collected.

#### *4.1.4.3 Precipitation and Fog Events*

Data from the NCDC shows the annual average precipitation is 47.16 inches (119.79 cm) in the Massachusetts coastal division. Monthly variations in average precipitation in the division are shown in Table 4.1.4-5 with a high of 4.38 in (11.12 cm) in November and a low of 3.39 in (8.61 cm) in July.

Fog is a fairly common occurrence over the area. Fog is especially frequent and persistent at times in areas south of Cape Cod resulting in significant restricted visibility. On average, the Nantucket area experiences fog on approximately one day out of six as shown in Table 4.1.4-6. Also shown in Table 4.1.4-6 is that almost all of the days with low visibility can be attributed to fog.

Although snowfall can vary significantly over small distances, representative monthly and annual snowfall amounts for the Massachusetts coastal division are presented in Table 4.1.4-7. These data were recorded in Hyannis, Massachusetts from 1971 through 2000 and indicate that the highest average monthly snowfall is 6.9 inches (17.5 cm) in January and the annual average is 18.4 inches (46.7 cm).

General information concerning the frequency of freezing precipitation is available in "A Climatography of Freezing Rain, Freezing Drizzle, and Ice Pellets across North America" (Cortinas et al., 2000). Isopleths presented in this paper indicate that freezing rain occurs from 0 to 10 hours per year.

#### *4.1.4.4 Hurricanes*

There have been 10 hurricanes that have impacted Massachusetts in the last 154 years (NHC, 2005). Five of the hurricanes were Category One hurricanes on the Saffir-Sampson Hurricane Scale, two were Category Two hurricanes, and three were Category Three hurricanes. No Category Four or Five hurricanes have been recorded in Massachusetts in the last 154 years.

A Category One hurricane has winds 74 to 95 mph (33 to 42.5 m/s) and a storm surge 4 to 5 ft (1.2 to 1.5 m) above normal. Damage due to a Category One storm is primarily to unanchored mobile homes, shrubbery, and trees. Some coastal flooding and minor pier damage could also be expected. A Category Two hurricane has winds 96 to 110 mph (43 to 49.1 m/s) and a storm surge generally 6 to 8 ft (1.8 to 2.4 m) above normal. Category Two hurricane damage may include roofing material, doors, and windows of buildings and considerable damage to mobile homes, shrubbery, trees, poorly constructed signs, and piers. Coastal and low-lying flooding is expected before the arrival of the hurricane center. A Category Three hurricane has winds 111 to 130 mph (49.6 to 58.1 m/s) and a storm surge 9 to 12 ft (2.7 to 3.7 m) above normal. Some structural damage to small residences and utility buildings, damage to shrubbery and trees with foliage blown off and trees blown down, mobile homes and poorly constructed buildings are destroyed, and coastal and low-lying flooding are possible damages due to a Category Three hurricane.

#### 4.1.4.5 Mixing Height

Average seasonal mixing height data within the Massachusetts coastal division are presented in Table 4.1.4-8. As shown in the table, the minimum average mixing height in the division is 1,276 ft (389 m), while the maximum average mixing height in the division is 4,662 ft (1,421 m). The minimum average mixing height is much higher than the height of top of the proposed rotors (440 ft [134.1 m]).

### 4.1.5 Air Quality

One measure of air quality within a region is whether background ambient air concentrations are in attainment with National Ambient Air Quality Standards (NAAQS). The NAAQS were developed by the USEPA for criteria pollutants to protect human health and welfare. The attainment status of an area is determined through an evaluation of available air quality data. The MassDEP and Rhode Island Department of Environmental Management collect ambient air quality data from a network of monitors located within their respective states. The network is designed to provide data representative of pollutant concentrations over large areas and also to determine concentrations in areas where they are expected to be the highest.

#### 4.1.5.1 Existing Air Quality

The MassDEP and monitoring data show that Massachusetts and Rhode Island are in attainment with the NAAQS for all criteria pollutants except ozone. Available monitoring data show that the 8-hour NAAQS for ozone has been exceeded at several monitors across each of the states, and all of Massachusetts and Rhode Island have been classified as moderate non-attainment areas with respect to the 8-hour NAAQS for ozone. Figure 4.1.5-1 graphically depicts the non-attainment areas within Massachusetts and Rhode Island. Ground level ozone is created through chemical reactions involving precursor pollutants ($NO_x$ and volatile organic compounds [VOCs]) in the presence of sunlight. Motor vehicles and fossil fuel fired power plants are among the major contributors to ozone precursor emissions.

The USEPA regulations, published as "General Conformity Rule" (58 FR 63214, November 30, 1993) to implement section 176(c) of the CCA for non-attainment areas and maintenance areas, require that Federal actions, unless exempt, conform with the federally-approved state implementation plan (SIP). Air emissions, within nonattainment areas, that are not covered by an air permit and that exceed the minimal levels require a conformity analysis.

#### 4.1.5.2 Regional Air Quality

The entire Commonwealth of Massachusetts and State of Rhode Island have been classified as being in attainment with NAAQS for all criteria pollutants, with the exception of ozone. However, some local variations in air quality may exist due to differences in meteorological conditions and emission sources. Local air quality has been evaluated by examining data obtained from individual monitoring stations. Qualitative assessments of influences on local air quality have also been made based on a consideration of air emissions generating activities and operations conducted in each local area.

Recent ambient air quality data (2004-2006) from the MassDEP and the DEM monitoring stations in the study area have been summarized and presented in Table 4.1.5-1. In accordance with USEPA policy, highest second high monitored concentrations, as opposed to maximum concentrations, are presented in Table 4.1.5-1 for pollutants with short-term standards, since one exceedence of the standard is allowed per year.

These data were recorded at monitoring stations closest to the site of the proposed action and are considered representative of air quality conditions at the onshore portions the site of the proposed action. Where multiple sites were approximately equal in distance to Nantucket Sound, all were evaluated and the highest value was presented in Table 4.1.5-1. Table 4.1.5-2 provides some summary information concerning the nearest monitors and their intended purpose, while Figures 4.1.5-2 through 4.1.5-7 show the locations of the monitoring sites.

As shown in Table 4.1.5-1, there have been exceedences of the 8-hour ozone NAAQS recorded at the Oak Bluffs, Massachusetts, and Narragansett, Rhode Island, monitors over the last three years (2004-2006). At the Oak Bluffs ozone monitor a total of 8 days had an 8-hour ozone NAAQS exceedence during this period with four days during 2005 and four days during 2006. Table 4.1.5-3 presents the dates of these monitored exceedences and the recorded 8-hour ozone concentration. An examination of the wind direction data for these 8 days of exceedences reveals that winds were predominately from the west and southwest indicating probable regional transport of ozone or its precursors from areas west to southwest of New England. Figures 4.1.5-8 through 4.1.5-15 show 8-hour ozone contours for each of the days with a recorded exceedence of the 8-hour ozone standard and the weather conditions during each of the days.

Information in the *Commonwealth of Massachusetts 2005 Air Quality Report* (MassDEP, 2006) and the *2004 Air Quality Summary, State of Rhode Island* (DEM, 2006) were reviewed to obtain information on how air quality, as measured at the air quality monitors, varied within the study area over recent years. In general, the information in these air quality reports indicates that the air quality in the study area has been improving over the durations monitored for each pollutant. Figure 4.1.5-16 presents a graph of the recorded annual $SO_2$ concentrations from 1985 through 2005. As the graph shows, there has been a slight decrease in the annual $SO_2$ concentrations recorded throughout Massachusetts over the last 21 years.

The annual $PM_{10}$ concentrations recorded in Rhode Island between 1994 and 2004 years are presented in Figure 4.1.5-17. The highest $PM_{10}$ levels measured each year through 2001 were at the Allens Avenue site, which was located immediately adjacent to Route I-95 in Providence. That site reflected worst-case levels and was not representative of neighborhood exposures. Monitoring at the Allens Avenue site was discontinued in 2002 due to extensive construction and demolition activity in the area associated with a highway relocation project. Since the discontinuation of the Allens Avenue site, the monitor at the Vernon Street site, which is located near Route I-95 in Pawtucket, consistently records the highest annual mean $PM_{10}$ levels in the State. The annual mean $PM_{10}$ concentrations at the Vernon Street site in 2004, as in the two previous years, were approximately 3 micrograms per cubic meter ($\mu g/m^3$) higher than at the other urban sites and approximately double that of the rural West Greenwich site. However, over the last ten years the monitored $PM_{10}$ concentrations show a slight decrease.

Recorded annual $NO_2$ concentrations from 1985 through 2005 are shown in Figure 4.1.5-18 and indicate that, similar to annual $SO_2$ and $PM_{10}$ concentrations, the annual $NO_2$ concentrations have decreased slightly since 1985 at all the monitors in Massachusetts. Figure 4.1.5-19 shows the 8-hour CO concentrations recorded in Rhode Island from 1992 to 2004. Maximum 8-hour CO concentrations at the Dorrance Street site, the only site that has operated continuously since 1990, decreased during the period. The CO concentrations at the East Providence site remained roughly constant between 1998 and 2002, but decreased in 2003 and 2004. Previously, the CO levels at the Dorrance Street site were significantly higher than those in East Providence, but due to the steady decrease in the monitored concentrations at the Dorrance Street site, the CO concentrations at the two sites have been similar since 2002.

The Oak Bluffs, Massachusetts, ozone monitor has only been in operation since 2004, so no trends of ozone concentrations can be inferred from this monitoring location. However, MassDEP does have a network of other ozone monitors throughout the State with the nearest ones being the Truro, Easton, and Fairhaven monitors. Figure 4.1.5-20 presents a graph of the number of 8-hour ozone NAAQS exceedences recorded per year from 1985 through 2005 at these three ozone monitors. As the graph shows, the number of recorded exceedences is variable from year-to-year, but overall there has been a slight decrease in the number of exceedences recorded.

According to the *Commonwealth of Massachusetts 2005 Air Quality Report* (MassDEP, 2006), the MassDEP $PM_{2.5}$ sampling network has been operating only since January 1999 and an ambitious program of sampler replacement has been accomplished since December 2004 in conjunction with a rigorous preventative maintenance program to improve overall data capture. The report provides no trend information, apparently because there has been too short a record of consistent quality. However, examining the three years of $PM_{2.5}$ concentrations presented in Table 4.1.5-1 shows that the 24-hour $PM_{2.5}$ concentrations have been variable over this time period, while the annual $PM_{2.5}$ concentrations have decreased each year.

**Nantucket Sound**

There are no air quality monitoring stations in Nantucket Sound. Emissions from onshore and upwind are transported and dispersed over the Sound. Additionally, emissions from mobile sources within the area, including recreational and commercial vessels, and low flying aircraft contribute to the air quality impacts offshore.

### 4.1.6 Water Quality

Under Massachusetts Surface Water Quality Standards (314 CMR 4.06(3)), Lewis Bay and the surface waters adjacent to Nantucket Island are categorized as Class SA coastal and marine water bodies. (Other waters of Nantucket Sound in the area of the proposed action are not classified.) According to the MassDEP standards, Class SA waters are designated as “an excellent source of habitat for fish, other aquatic life and wildlife, and for primary and secondary contact recreation.” In approved areas, Class SA waters are suitable for shellfish harvesting without the need for depuration (that is, removal of contaminants) (Open Shellfish Areas).

#### *4.1.6.1 Freshwater Resources*

##### 4.1.6.1.1 Groundwater

No sites associated with releases/spills of petroleum products or hazardous substances that have been reported to the appropriate agencies identified in the Environmental First Search Report (ESS, 2005) appear to be located within the proposed on land cable route. As indicated in the MEPA FEIR, the Environmental First Search Report did describe eleven state-listed oil and/or hazardous material disposal sites including two disposal sites and nine spill sites, within 0.25 miles (0.4 km) of the proposed cable route. None of these sites are crossed by the route, and none appear to pose a risk to soils and/or groundwater quality conditions along the proposed cable route. An additional three underground storage tanks are within 0.25 miles (0.4 km) of the proposed upland cable route, but none are currently listed as a location where a release or spill of materials has occurred. Based on review of the Federal CERCLIS list dated 4/14/2005, and the National Priorities List (NPL) dated 5/17/2005, there are no CERCLIS or NPL sites located within 0.25 mile (0.4 km) of the proposed on land cable route.

The environmental conditions on the known state-listed oil and/or hazardous material release and spill sites identified in close proximity to the proposed on land cable route do not appear to have impacted soil and/or groundwater quality conditions within the proposed cable route.

Onshore construction of the proposed action is located within the EPA-designated Cape Cod Sole Source Aquifer. The Cape Cod aquifer consists of shallow glacial outwash deposits, recharged primarily through precipitation (Olcott, 1995). Groundwater flow is from high areas of Cape Cod, to lower areas, where it is discharged from the aquifer back to the land surface or directly to the ocean (Olcott, 1995).

The proposed action is located within Zone I and Zone II Wellhead Protection Areas for public supply wells, as designated by MassDEP regulations. The MassDEP regulations (310 CMR 22.21(1)(b)(5)) state that current and future land uses within the Zone I shall be limited to land uses directly related to the public water system or to other land uses which the public water system has demonstrated would have no adverse impact on water quality. The regulations also state that no new underground storage tanks for petroleum products shall be located within Zone I. According to the MassDEP regulations, Zone II is defined as: that area of an aquifer that contributes water to a well under the most severe pumping and recharge conditions that can be realistically anticipated (180 days of pumping at the approved yield, with no recharge from precipitation).

#### 4.1.6.1.2 Freshwater Streams

Under Massachusetts Surface Water Quality Standards (314 CMR 4.06(2) (b)), the water resources located along the onshore route are classified as Class B, High Quality Water by MassDEP. According to the MassDEP standards, Class B waters are designated as "habitat for fish, other aquatic life and wildlife, and for primary and secondary contact recreation." In approved areas, Class B waters are suitable as a source of public water supply with appropriate treatment.

Thornton Brook is mapped as a perennial stream on the current USGS map, however, the stream channel was observed completely dry during fieldwork conducted in October 2001 and December 2002. In addition, Thornton Brook was observed to be dry over four days of field observation during July 16, August 3, 15, 16, and 17 of 2007, during non-drought conditions, and documented as dry. Pursuant to 310 CMR 10.58 (2) (a) 1.d., the issuing authority shall find that any stream is intermittent based upon a documented field observation that the stream is not flowing. In addition the Yarmouth Conservation Administrator has confirmed that Thornton Brook is not perennial. Thornton Brook is intermittent and does not have an associated Riverfront Area.

#### 4.1.6.1.3 Freshwater Wetlands

In addition to establishing wetland setbacks, the Yarmouth Wetlands Protection Regulations (WPR) govern work within Lake and Pond Recharge Areas. These areas are defined under Section 3.05 as wetland and upland landforms that contribute surface and subsurface water to the lakes and ponds of the towns and are mapped within a "Water Resources Protection Study" prepared for the Town of Yarmouth (Figure 4.1.6-1). Conservation Commission jurisdiction is restricted to mapped areas within 300 ft (91.4 m) of a lake or pond. The proposed onshore transmission cable system route would be located within the mapped recharge areas of Jabinettes Pond (Wetland 2) and Long Pond (Wetland 6). As such, groundwater flow from portions of the transmission cable route has the potential to affect water quality in Jabinettes Pond and Long Pond. The regulations at Section 3.05(3) prohibit land use practices that present serious threats to the quality of lake and pond recharge areas, including: outdated underground storage tanks, landfills, stump dumps, road salt storage, package treatment plants, and automotive and construction equipment repairs. The proposed transmission cable system is not a land use that is specifically prohibited under these regulations.

### *4.1.6.2 Coastal Waters*

#### 4.1.6.2.1 Estuaries and Bays

On December 14, 2004, sampling was conducted within Lewis Bay at the proposed temporary cofferdam location for the potential HDD drill exit points. Sediment samples from vibratory cores (vibracores) were collected and analyzed to determine bulk chemical and physical characteristics of the material to be dredged from Lewis Bay. The sampling protocol and testing analyses were performed in accordance with the MassDEP-DWPC Regulations 314 CMR 9.00.[11]

A total of four vibracores were advanced in the vicinity of the proposed action's landfall. Three of the vibracores (VC04-01, VC04-02, and VC04-03) were advanced within the area of the proposed temporary cofferdam dredging. The fourth vibracore was advanced near the seawall at the end of New Hampshire Avenue. Figure 4.1.6-2 shows the locations of the vibracores.[12]

The sample results of the bulk chemical and physical analyses were compared with the MassDEP-DWPC classification criteria found in 314 CMR 9.07 for dredging and dredged material disposal. Table's 4.1.6-1 and 4.1.6-2 show the classifications of the sediment samples based on chemical constituents and physical characteristics as established in the regulations. Note that results from only the three vibracores located within the proposed dredge footprint are provided since this data set would be what is reviewed by MassDEP as part of the 401 WQC process. Based on MassDEP criteria, the dredge material was classified as Category 1, Type A.

Methods for dredging and disposal activities that the MassDEP-DWPC may approve are dependent upon the chemical and physical classification of the sediment to be removed. Approvable options for various sediment types are summarized in Table 4.1.6-3. Sediment types identified in this sample analysis are approvable for either hydraulic or mechanical dredging methods. Unconfined in-harbor disposal (in the case of this Project; replacement of dredged material) is normally approvable by MassDEP as determined from the sediment constituents.

The sampling protocol was based on the following references:

- Quality Assurance/Quality Control for 301(h) Monitoring Programs: Guidance on Field and Laboratory Methods, dated March 1987 (USEPA 430/9-86-004).
- Analytical Methods for USEPA Priority Pollutants and 301(h) Pesticides in Estuarine and Marine Sediments, dated May 1986 and prepared by Tetra Tech (USEPA 68-01-6938), TC-3953-03 Final Report.
- User's Guide to Contract Laboratory Program, dated December 1988 (USEPA/540/8-89/012).
- Evaluation of Dredged Material Proposed for Ocean Disposal: Testing Manual, dated February 1991 (USEPA 503/8-91/001).

[11] MassDEP Regulations Effective 3/1/95.

[12] Subsequent to the nearshore vibracore field program study, MADEP Regulations 314 CMR 9.00 were revised on December 29, 2006. Per 314 CMR 9.07(2) as part of the sampling and analysis requirements, an applicant shall perform a "due diligence' review to determine the potential for the sediment proposed to be dredged to have concentrations of oil or hazardous materials. Furthermore, 314 CMR 9.07(2)(a), stated that "no chemical testing shall be required if the sediment to be dredged contains less than 10 percent by weight of particles passing the No. 200 U.S. Standard Series Testing Sieve and if the "due diligence" review demonstrates, to the Department's satisfaction, that the area is unlikely to contain anthropogenic concentrations of oil or hazardous material." Furthermore, the sediment results show that the sediment located within the area to be dredged contains less than 10 percent by weight of particles passing the No. 200 U.S. Standard Series Testing Sieve. The sample results of the bulk chemical and physical analyses were compared with the 1995 MADEP-DWPC classification criteria found in 314 CMR 9.07(2) for dredging and dredged material disposal. The December 29, 2006 revised Regulations do not establish chemical and physical classification criteria. Table's 4.1.6-1 and 4.1.6-2 show the classifications of the sediment samples based on chemical constituents and physical characteristics as established in the 1995 regulations.

- 401 WQC For Discharge of Dredged or Fill Material, Dredging, and Dredging Material Disposal in Waters of the United States Within the Commonwealth, dated March 1, 1995 (314 CMR 9.00).
- Guidance for Performing Tests on Dredged Material in Open Waters, dated May 15, 1989 (USEPA Region 1 and USACE, New England Division).
- Technical Guidance for Screening Contaminated Sediments, dated January 1999 (New York State Department of Environmental Conservation).

The primary surface waterbodies in the area of the proposed action are Nantucket Sound, Hyannis Harbor, and Lewis Bay. As mentioned above, these waterbodies are categorized as Class SA by MassDEP. Lewis Bay and Hyannis Harbor are listed on the Massachusetts Section 303(d) List of Waters as impaired due to the presence of pathogens in water quality samples. However, no specific sources of pathogen pollution were reported by the Commonwealth in its 304(b) report to USEPA (USEPA, 2002).

The Barnstable County Department of Health and Environment and the Towns of Yarmouth and Barnstable collect additional information on the water quality of Lewis Bay and Hyannis Harbor. The waters offshore of Cape Cod's bathing beaches are sampled during the summer for the bacterial indicator organisms E. coli and enterococci. The beaches sampled as part of this program that are closest to the proposed action landfall are Englewood Beach in Yarmouth; and Veterans Beach, Keys Beaches and Kalmus Beach in Barnstable. None of the results of these samples exceeded established local and Massachusetts Surface Water Quality Standards at 314 CMR 4.06(2)(b) (Barnstable County, 2002).

### *4.1.6.3 Offshore Waters*

#### 4.1.6.3.1 Continental Shelf

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 shoal areas.

When the approach of average waves (2.6 second period, 1.6 ft [0.49 m] height) is aligned with running tidal currents, near-bottom suspended sediment concentrations in Nantucket Sound are estimated to be approximately 71 milligrams per liter (mg/L). When average waves (2.2 second period, 1.3 ft [0.40 m] height) approach perpendicular to running tidal currents, near-bottom suspended sediment concentrations in Nantucket Sound are estimated to be approximately 45 mg/L (Woods Hole Group, 2003, 2004, 2005).

Analysis from the sediment core samples obtained from the area of the proposed action indicated that sediment contaminant levels were below established thresholds in reference to sediment guidelines (see Tables 4.1.6-4 thru 4.1.6-7). Specifically, all of the chemical constituents detected in the sediment core samples obtained from the WTG array site and along the submarine transmission cable route had concentrations below Effects Range-Low (ER-L) and Effects Range-Median (ER-M) marine sediment quality guidelines (Long et al., 1995). To assess the relative environmental quality of the sediments collected from the area of the proposed action, the analytical laboratory results for targeted chemical constituents were compared to established guidelines for marine and estuarine sediments, particularly Long et al., 1995. To aid in the identification of contaminants of potential ecological concern, federal and state agencies (such as NOAA, MADEP) use these site-related sediment data to compare established screening level criteria. These guidelines were not promulgated as regulatory criteria or standards as they were not intended as cleanup or remediation targets, discharge attainment targets or intended as a pass-fail criterion for dredged material disposal decisions or any other regulatory purpose. They were intended as an informal guideline for use in interpreting chemical data from analyses of sediments.

The Long et al. (1995) marine/estuarine ER-L screening values represent a concentration at which adverse benthic impacts are found in approximately 10 percent of studies. A level greater than the ER-M indicates a greater than 50 percent incidence of adverse effects to sensitive species and/or life stages. A concentration between the ER-L and ER-M therefore indicates an expected impact frequency between 10 percent and 50 percent. The ER-L and ER-M values were not derived as toxicity thresholds. That is, there is no assurance that there would be a total lack of toxicity when chemical concentrations are less than the ERL values. Similarly, there is no assurance that samples in which ER-M values are exceeded would be toxic. Toxicity, or a lack thereof, must be confirmed with empirical data from toxicity tests. The ERL values were intended and should be used primarily as estimates of the concentrations below which toxicity is least likely. The ERM values are better indicators of concentrations associated with effects than the ERLs.

## 4.1.7 Electrical and Magnetic Fields (EMF)

### *4.1.7.1 Introduction*

The information on EMFs contained in this section was obtained from review of existing data available for the area of the proposed action, the EMF monitoring and modeling conducted by the applicant, and review of the scientific literature on EMF. This introduction provides an overview of EMF; discusses potential sources of EMF; and summarizes the current status of research, in order to provide a context for the proposed action discussion. The assessment of EMF impacts anticipated is provided in Section 5.3.1.7.

Electric power transmission and distribution (T&D) lines create EMFs because they carry electric currents at high voltages. The voltages and currents are produced by electric charges. Electric charges (electrons and protons) are present in all matter, and can give rise to electrical effects. Most objects are electrically neutral because positive and negative charges are present in equal numbers. When the balance of electric charges is altered, electrical effects result such as the attraction between a comb and our hair, the drawing of sparks after walking on a synthetic rug in the wintertime, or the presence of EMFs from power lines. The work put into separating electric charges is measured by *voltage*. The units of work-per-unit-charge are *volts* (V) or *kilovolts* (kV; 1 kV = 1000 V). Voltage is the “pressure” of electricity, and is analogous to the pressure of water in a plumbing system.

Electric charges push and pull on other charges and, therefore, each electric charge generates an *electric field* that exerts a force on nearby charges. Opposite charges (i.e., + and –) attract, and like charges (i.e., + and +) repel. Electric fields are equal to the “force per unit charge” and are measured in units of *volts/meter* (V/m) or *kilovolts/meter* (kV/m).

The movement of electric charges is called *electric current* and is measured in *amperes* (amps). Current measures the “flow” of electricity, which is analogous to the flow of water in a plumbing system. The moving charges in an electric current produce a *magnetic field* which exerts force on other moving charges. Wires carrying currents running in parallel attract, while wires carrying currents in opposite directions repel. This is the principle by which electric motors generate force.

The magnitude of a magnetic field, or magnetic flux density, is measured in *gauss* (G) or *tesla* (T) (1 T = 10,000 G). Smaller fields are measured in *milligauss* (1 milligauss (mG) = 0.001 G) or *microtesla* (1 µT = one-millionth of a tesla). Milligauss is the unit most often used to measure the strength of magnetic fields in electric transmission lines. Permanent magnets contain electrical currents at the atomic level that can generate strong magnetic fields, approximately 100 to 500 G (i.e., 100,000 to 500,000 mG). Thus, magnetic fields from permanent magnets can exert forces on electric currents, or on other magnetic objects, as for example, when a compass needle orients toward a magnet.

The strength of power line EMFs diminish with distance from the source similar to the light from a candle grows dimmer as you move away from it. The field strengths are constantly varying and decease as the inverse square of the distance from the source. For an electric transmission line, the EMF levels are highest next to the transmission lines (typically near the center of the ROW) and decrease as the distance from the transmission corridor increases. Electric fields are attenuated by objects, such as trees and walls of structures, and are completely shielded by electrically conducting material such as metal, the earth, or the surface of the body. Magnetic fields, on the other hand, penetrate most materials. Table 4.1.7-1 summarizes some of the characteristics of electric and magnetic fields.

Humans are exposed to a wide variety of natural and man-made electric and magnetic fields. The earth's atmosphere produces slowly-varying electric fields (about 0.1 to 10 kV/m) that occasionally manifest themselves as lightning. The earth's core produces a steady magnetic field, as can easily be demonstrated with a compass needle. The earth's magnetic field ranges in strength from about 470 mG to 590 mG over the United States, and is about 560 mG in the Northeast. Knowing the strength of the earth's fields provides a perspective on the size of the magnetic field measurements from an electric transmission line.

Man-made magnetic fields are common in everyday life. Many childhood toys contain magnets, and many of us use magnets to hold items on the metallic surface of refrigerators. These permanent magnets typically have fields (magnetic flux density) in excess of 100,000 mG. An increasingly common diagnostic procedure, magnetic resonance imaging, uses fields of 20,000,000 mG on humans and is considered safer than X-rays.

Electric transmission line currents are AC, because they change size and direction 60 times per second (60 cycles per second = 60 Hertz or 60 Hz). The AC currents produce AC magnetic fields; however, aside from the variation in time (60 Hz) that characterizes electric transmission line fields, they are identical in nature to steady fields, such as those due to the earth's atmosphere, or geomagnetism. Moreover, as human bodies move, the direction of the earth's magnetic field relative to this movement experiences a time-varying magnetic field, similar to AC magnetic fields.

Electric power transmission lines, distribution lines, and the electric power lines that come into our homes and workplaces are sources of electric and magnetic fields that vary in time at a frequency of 60 Hz (in North America) or 50 Hz (abroad). Magnetic fields are proportional to the current, and electric fields are proportional to the voltage on the wires; both decrease as distance from the electrical wires increases. EMFs from different sources (e.g., adjacent wires) may partially cancel or may add to the EMF level at any location. For residences, typical baseline 60 Hz magnetic fields in the middle of rooms range from 0.5 to 2.0 mG. These fields are, to a large extent, produced by outdoor distribution wiring, indoor wiring, and electric currents in ground return pathways.

In the home, 60 Hz EMFs can also be found in the vicinity of electric appliances, including fans, electric ranges, microwave ovens, refrigerators, clothes washers and dryers, fluorescent lights, televisions, toasters, vacuum cleaners, etc. Appliances produce magnetic flux densities in the range of 40 to 80 mG at distances of 1 ft, but the density quickly diminishes with distance. Personal electric appliances such as shavers, electric toothbrushes, hair dryers, massagers, electric toys, and electric blankets can produce magnetic flux densities measuring 100 mG or more in the vicinity of the appliance.

Table 4.1.7-2 summarizes the magnetic flux density associated with various devices and phenomena and several guidelines established by various organizations for certain occupations, individuals, and the general public. Table 4.1.7-3 further summarizes maximum allowable electric and magnetic field intensities at the edge of transmission line ROWs.

Power frequency EMF are part of a spectrum that encompasses frequencies that range from very high ionizing energy, such as gamma rays with frequencies of billions of cycles per second, to very low non-ionizing energy below that of power frequencies. Visible light is also included in this spectrum at the threshold between ionizing and non-ionizing electromagnetic waves. The greater the frequency of the electromagnetic energy source, the shorter the wavelength and the higher the energy. Lower frequency sources have longer wavelengths and correspondingly lower energy.

Power frequency fields are very low frequency fields (60 Hz in North America) with extremely long wavelengths of around 3,100 miles (5,000 km). Because of the extremely long wavelength, fields associated with power frequency are experienced as separate electric and magnetic fields and are therefore not considered radiation or emissions. They carry very little energy and cannot break chemical bonds or heat living tissue.

#### 4.1.7.1.1 Sources of Electric and Magnetic Fields Exposure

Electric and magnetic fields are common and exist in a wide variety of natural and man-made forms. Natural fields are associated with items used, such as the geomagnetic field of the earth and magnets. These natural fields are static and therefore do not switch back and forth like power frequency fields. Like electric appliances, overhead T&D lines are a common source of exposure to electric and magnetic fields. High voltage transmission lines can generate relatively high electric fields. However, because high voltage transmission lines are constructed along ROWs, and because electric fields drop off quickly with distance and are shielded by cable shields and physical obstacles, electric fields experienced by people within dwellings are typically dominated by the internal wiring and the use of appliances. Magnetic fields from transmission lines, although not able to be shielded by structures, also drop off quickly with distance. Therefore, magnetic fields within dwellings are also typically dominated by nearby distribution system wiring, house wiring, or appliance use. Electric and magnetic fields from different sources (e.g., adjacent wires) may partially cancel or be additive at a given location. Results of studies have shown that electric fields in the home, on average, range from zero to ten volts per meter and magnetic fields range from 0.6 to 3 mG (NIEHS, 2002).

Power frequency electric and magnetic fields can also be found in the vicinity of electric appliances, including fans, electric ranges, microwave ovens, can openers, refrigerators, clothes washers and dryers, fluorescent lights, televisions, toasters, vacuum cleaners, hair dryers, alarm clocks, electric blankets, and computers. Appliances produce magnetic fields that can range from one to 150 mG at distances of 1 ft (0.3 m) (NIEHS, 2002). These fields decrease in strength much more quickly with distance than do power line fields.

### *4.1.7.2 Onshore Environment Pre-Project*

Baseline measurements of power frequency (60 Hz) magnetic flux density were made on June 5 and 6, 2002, along the proposed onshore transmission cable route. Based upon these measurements and physical characteristics of the planned cable system, projections of the magnetic flux density were developed that would be representative of worst-case existing conditions during times of peak electrical loads. The baseline measurements were made along the street section of the route, and at representative locations along the NSTAR Electric 115 kV ROW.

Calculations were performed using the "ENVIRO" computer program, developed by the EPRI, to determine the magnetic flux densities expected along the onshore route as a result of the operation of the proposed transmission cable system, taking into account the effects of existing sources as well as the new transmission facilities. Calculations were performed with the proposed action generating at a maximum delivered output of 454 MW and at the annual average output of 168 MW. All measurements and calculations were performed at 3.3 ft (1 m) above grade.

Electric fields were not measured nor studied in any detail for the following reasons:

- The electric field of the proposed 115 kV cables would be effectively contained within the body of each cable (i.e., shielded) by its grounded metallic shield;
- Electric field strength is a function of power line voltage and the operating voltage of NSTAR Electric's existing overhead T&D lines would not be changed by the proposed facilities (and thus, the resulting electric field strengths would not change);
- The focus of potential health effects of power frequency fields has been primarily with magnetic rather than with electric fields; and
- Calculations performed to determine existing electric field strengths and those expected after any proposed modifications to NSTAR Electric's 115 kV transmission lines show that the existing and predicted electric field levels at the edge of NSTAR Electric's ROW are well below 0.55 kV/ft (1.8 kV/m), which has been used as a guideline by the Commonwealth of Massachusetts EFSB. The maximum electric field strength in and adjacent to the streets along the proposed route of the onshore transmission cable system is on the order of 0.03 kV/ft (0.1 kV/m).

#### 4.1.7.2.1 Landfall to NSTAR Electric ROW

The primary sources of existing power frequency EMF along the street portion of the proposed onshore transmission cable system route are the existing overhead distribution lines. Their nominal operating voltage is 23 kV phase-to-phase/13.2 kV phase-to-ground. They are fed radially from Distribution Line 92, which emanates from Hyannis Junction Substation. Proceeding in a southerly direction down the route (away from the substation and towards the landfall location), the load current on the lines decreases as the trunk circuit extends along the route branching to other distribution circuits. At New Hampshire Avenue, the line changes from 3-phase to single phase. Measured magnetic flux density at the edge of the pavement closest to the overhead line ranged from 1 to 21 mG along the length of the route, generally increasing in a northerly direction consistent with increasing current. Representative measurements directly under the lines did not exceed these values by more than 1 mG. At the time of the measurements, total load on Line 92 was about 14 MW. Line 92 experienced a 27 MW load during the historical system peak on August 9, 2001 (Report No. 4.1.7-1). Extrapolating to these load levels produces maximum magnetic flux density in the range of 2 to 40 mG, although local field strengths may vary depending on conductor geometry and individual loads. The measured field strength directly under the lines in front of the Marguerite E. Small School was 5 mG or 9 mG when extrapolated to peak load.

Calculated existing electric field strengths in and adjacent to the streets along this route range between 0.032 and 0.29 kV/ft (0.01 and 0.09 kV/m).

#### 4.1.7.2.2 Within the NSTAR Electric Right-of-Way

Magnetic flux density was measured under existing 115 kV lines 118 and 119 and existing 23 kV lines in the NSTAR Electric ROW where it crosses Willow Street at the low point in the lines. The highest field strength measurements were found at this location. The location is representative of the field strengths on the existing ROW between Harwich Tap and Barnstable Switching Station. Current flow at the time of the measurements was 296 Amps in line 118 and 143 Amps in Line 119. The magnetic flux density was highest under the 118/119 lines, at 26 mG, falling to 18 mG at the north edge of the ROW, and 6 mG at the south edge of the ROW. Using the same line geometry (which is much better defined and more consistent than for the in-street distribution circuits), the corresponding magnetic flux densities were calculated at NSTAR Electric's forecast peak loading (without the proposed action) of 643 Amps on line 118 and 311 Amps on line 119. This resulted in 127 mG directly under the lines, 56 mG at the north edge of the ROW, and 12 mG at the south edge of the ROW.

Calculated existing electric field strength directly under the 115 kV overhead lines 118 and 119 is 2.0 kV/m. At the north edge of the ROW, this falls to 0.2 kV/m, and is less than 0.1 kV/m at south edge of ROW.

#### *4.1.7.3 Offshore Environment Pre-Project*

##### 4.1.7.3.1 Conditions in Nantucket Sound

There are no known power facilities in the waters of Lewis Bay or Nantucket Sound in the vicinity of Horseshoe Shoal, with the exception of the existing Nantucket cable that runs from Nantucket to Cape Cod, which may also have low levels of EMF associated with its operation. Further to the west of the site of the proposed action are existing electric cables that run between Falmouth and Martha's Vineyard. The only other pre-project magnetic field existing in the location of the proposed 115 kV submarine transmission cable is the natural geo-magnetic field of the earth, which is a static DC field that is oriented toward the North and downward into the earth.

## 4.2 BIOLOGICAL RESOURCES

### 4.2.1 Terrestrial Vegetation

The terrestrial vegetation associated with this proposed action is located along the onshore transmission cable system route starting at the landfall location in Yarmouth, Massachusetts and heading to Barnstable Switching Station. The proposed onshore transmission cable system route runs north from the landfall at New Hampshire Avenue in Yarmouth for approximately 4 miles (6.4 km) along Berry Avenue, Higgins Crowell Road, and Willow Street. The route leaves the roadways for approximately 2 miles (3.2 km) then heads west and then south along the existing NSTAR Electric ROW to the Barnstable Switching Station.

The information contained in this section was obtained from literature review, agency consultations, site investigations, and review of existing site investigation data. This section provides characterization of salt marsh, freshwater wetland, and upland vegetation that occurs along the on land transmission cable route, including mapping of wetland boundaries and buffer zones, and an explanation of the significance of each wetland area to the interests enumerated in the WPA.

#### *4.2.1.1 Woodlands*

The upland vegetated communities located adjacent to the roadway portion of the proposed transmission cable system route are primarily pitch pine-oak forests dominated by white oak (*Quercus alba*), pitch pine (*Pinus rigida*), scrub oak (*Quercus ilicifolia*), lowbush blueberry (*Vaccinium angustifolium*), and sassafras (*Sassafras albidum*). Soils in these areas were observed to be sandy and are mapped as Carver coarse sand and Carver loamy coarse sand (NRCS, December 15, 2006). The woodland vegetation adjacent to the project terrestrial path is typical of Cape Cod consisting of trees of various age classes and distribution.

#### 4.2.1.2 Fields and Open Space

The on-land transmission cable corridor does not intersect any naturally occurring field or open space areas. The managed NSTAR Electric ROW contains upland vegetation that is maintained as scrub/shrub community, with the primary cover consisting of interspersed woody and herbaceous species that vary in density along the ROW. The ROW is managed in compliance with NSTAR's vegetation management plan. Common species observed include black oak (*Quercus velutina*), sassafras, greenbrier (*Smilax glauca*), bearberry (*Arctostaphylos uva-uri*), poison ivy (*Toxicodendron radicans*), and knapweed (*Centaurea jacea*). Soils along the ROW consist of medium to coarse sands, and are mapped as Plymouth-Barnstable complex. (NRCS, December 15, 2006). In addition to the scrub/shrub community of the ROW there are also residential yards adjacent to the roadways that could be considered open spaces with vegetation consisting of mowed grasses and ornamental landscaping.

#### 4.2.1.3 Freshwater Wetlands

Wetlands in the area of the proposed action were characterized based on review of mapped resources, wetland field investigations, and related studies completed as part of the proposed action siting and permitting process. The following sources were reviewed as part of this characterization:

- USGS Topographic Map, Dennis and Hyannis Quadrangles
- USGS Aerial Photos dated March 5, 1995 and April 3, 1995
- MassGIS data on mapped wetland resources, open space mapping, endangered species
- Lake and Pond Recharge Areas Map, prepared for Town of Yarmouth by IEP, Inc. (August 1988)
- MassDEP SAV Mapping Inventory for 1995, and 2001
- SAV Diver Survey, Woods Hole Group, Inc. July 2003
- SAV Investigation Cape Wind Energy Project Nantucket Sound, Massachusetts, August 2006
- Ocean Surveys, Inc. (OSI) Plan Drawing 01ES047.2, Sheet 1 of 7
- Massachusetts NHESP records
- Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRM), Town of Yarmouth, Barnstable County, Community Panel Numbers 250015 003C (June 17, 1986) and 250015 005D (July 2, 1992)
- FEMA FIRM, Town of Barnstable, Barnstable County, Community Panel Number 250001 0005C (August 19, 1985)
- National Resources Conservation Service (NRCS) Soil Survey Geographic (SSURGO) database for Barnstable County, Massachusetts (December 15, 2006)
- NOAA Published Bench Mark Data, Hyannis Harbor, Massachusetts (September 29, 1989)
- Coastal Watersheds Map, prepared for Town of Yarmouth by IEP, Inc. (August 1988)
- Town of Yarmouth GIS database

- Town of Yarmouth Comprehensive Plan, Chapter 7 Coastal Resources (March 20, 1997)

Wetlands have been identified in the vicinity of the area of the proposed action seaward and within the state territorial limit of Nantucket Sound and Lewis Bay, and along the onshore transmission cable route. Portions of the submarine and onshore transmission route fall within the town boundaries of Barnstable and Yarmouth. Wetlands in the area of the proposed action are generally defined and regulated according to the following Federal, State, and local wetland regulations:

- Section 10 of the Rivers and Harbors Act of 1899 (U.S.C. 403)
- Section 404 of the CWA (33 U.S.C. 1344)
- ESA of 1973 (16 U.S.C. 1531-1543)
- WPA (M.G.L. c. 131, §40), Rivers Protection Act (Ch. 258 of the Acts of 1996), and regulations (310 CMR 10.00)
- Section 401 WQC (33 U.S.C. 1251, et seq.) and regulations (314 CMR 9.00)
- Coastal Wetlands Restriction Act (M.G.L. c. 131, §105)
- Coastal Zone Management Act of 1972 (16 U.S.C. §1451 to 1465), and regulations (301 CMR 20.00-21.00)
- Chapter 91 Waterways License (310 CMR 9.00)
- Massachusetts ESA (M.G.L. c. 131 §40) and regulations (321 CMR 10.00)
- Cape Cod Commission Act (Ch. 716 of the Acts of 1989 and Ch. 2 of the Acts of 1990)
- Cape Cod Atlas of Tidally Restricted Salt Marshes, Cape Cod, Massachusetts (December 2001)
- Yarmouth Wetlands Protection By-law and Regulations (Chapter 143)
- Barnstable Wetlands Protection Ordinance (Article 27)

There are several freshwater wetlands located adjacent to the proposed terrestrial route. These wetlands include Jabinettes Pond, Thornton Brook, red maple swamps, an Atlantic white cedar swamp, and a coastal plain pond. All areas potentially subject to Federal, state, or local jurisdiction within 200 ft (61 m) of the onshore transmission route were field investigated in October 2001, August 2002, and December 2002. Wetlands were delineated in December 2002, in accordance with criteria established by the USACE, MassDEP, and the Yarmouth WPR. It should be noted that there are no wetland resource areas located along or within 100 ft (30.5 m) of the onshore transmission route within Barnstable. Vegetated wetland boundaries were surveyed using GPS.

Six freshwater wetland systems, as shown on Figure 4.2.1-1, were identified within approximately 100 ft (30.5 m) of the proposed onshore transmission cable route in Yarmouth. A locally regulated isolated wetland north of Water Street and east of Berry Avenue was also identified during field investigations. Because this wetland area is slightly more than 100 ft (30.5 m) from the transmission cable route, it is not within the jurisdiction for this proposed action. The following provides a description of those six wetland resource areas, as shown on Figure 4.2.1-1, within 100 ft (30.5 m) of the onshore transmission cable route.

- **Wetland 1 – Bordering Vegetated Wetland (BVW), Bank, Waters of the United States (local, State, and Federal jurisdiction)** is an Atlantic white cedar (*Chamaecyparis thyoides*) swamp located on the east and west sides of Higgins Crowell Road in Yarmouth. The wetland is within approximately 60 ft (18.3 m) of the road, and is located at a well-defined break in slope. A 12-inch (30.5 cm) concrete culvert beneath the road appears to connect the east and west wetland areas, and this wetland is therefore regulated as Bank and Waters of the United States. On the east side of the road, the wetland is relatively undisturbed and consists of a mixed cedar, tupelo (*Nyssa sylvatica*), and red maple (*Acer rubrum*) canopy. There is also a shrub layer with highbush blueberry (*Vaccinium corymbosum*), sweet pepperbush (*Clethra alnifolia*), green briar (*Smilax rotundifolia*), fetterbush (*Leucothoe racemosa*), and swamp azalea (*Rhododendron viscosum*). On the west side of the road, the majority of the mature Atlantic white cedars are dead or in decline. Vegetation includes live sapling Atlantic white cedars, red maple, tupelo, inkberry (*Ilex glabra*), sweet pepperbush, green briar, highbush blueberry, water willow (*Decodon verticillatus*), and wool grass (*Scirpus cyperinus*). This wetland is regulated as BVW and Bank, and has a 100 ft (30.5 m) Buffer Zone under the Massachusetts WPA, and a 50 ft (15.2 m) No-Build Zone and 35 ft (10.7 m) Vegetated Buffer under the Yarmouth WPR. Wetland 1 is regulated as Waters of the United States by the USACE.

- **Wetland 2 – BVW, Bank, Land Under Waterbodies and Waterways (LUWW), Waters of the United States** (local, State, and Federal jurisdiction) consists of Jabinettes Pond, on the east side of Higgins Crowell Road, and Thornton Brook, located on both the east and west side of the road. A vegetated wetland abutting Jabinettes Pond is located within 100 ft (30.5 m) of the proposed onshore transmission cable route. It is dominated by red maple, tupelo, highbush blueberry, sweet pepperbush, spicebush (*Lindera benzoin*), green briar, and sensitive fern (*Onoclea sensibilis*). Jabinettes Pond discharges into Thornton Brook, which appears to flow west and crosses beneath Higgins Crowell Road via a buried culvert. Road runoff is also channeled via paved swales on both sides of Higgins Crowell Road into Thornton's Brook. The stream briefly appears aboveground on the west side flows in a culvert beneath an old vegetated road. An unused concrete flow control structure with a slot for flashboards was observed on the east end of the west side culvert. The stream finally appears aboveground into a defined channel with steep man-altered banks and flows southwest.

  Thornton Brook is mapped as a perennial stream on the current USGS map, and it is presumed to be perennial under 310 CMR 10.58(2) (a) (1) (a). However, Thornton Brook was observed to be dry over four days of field observation during July 16, August 3, 15, 16, and 17 of 2007, during non-drought conditions, and was documented as dry. Pursuant to 310 CMR 10.58 (2)(a)1.d., the issuing authority shall find that any stream is intermittent based upon a documented field observation that the stream is not flowing. In addition the Yarmouth Conservation Administrator has confirmed that Thornton Brook is not perennial. Thornton Brook is therefore intermittent and does not have an associated Riverfront Area.

  Wetland 2 is regulated as BVW, LUWW, and Bank. A 100 ft (30.5 m) Buffer Zone and 200 ft (61 m) Riverfront Area from Bank are jurisdictional under the Massachusetts WPA. The Yarmouth WPR regulate Wetland 2 as Vegetated Wetland, LUWW, and Bank with a 50 ft (15.2 m) No-Build Zone and 35 ft (10.7 m)

Vegetated Buffer. Wetland 2 is regulated as Waters of the United States by the USACE.

- **Wetland 3 – BVW, Bank, Waters of the United States** (local, state, and Federal jurisdiction) is a forested wetland located approximately 50 ft (15.2 m) west of Higgins Crowell Road in Yarmouth. The wetland is dominated by red maple, sweet pepperbush, highbush blueberry, inkberry, swamp azalea, fetterbush, cinnamon fern (*Osmunda cinnamomea*), and Sphagnum mosses. An intermittent stream channel flows west through the wetland and into Little Sandy Pond, located approximately 700 ft (213.4 m) west of Higgins Crowell Road. The intermittent stream channel was observed dry in areas in the vicinity of the wetland delineation in December 2002. Wetland 3 is regulated as BVW and Bank with a 100 ft (30.5 m) Buffer Zone under the Massachusetts WPA, and a 50 ft (15.2 m) No-Build Zone and 35 ft (10.7 m) Vegetated Buffer under the Yarmouth WPR. This wetland is regulated as Waters of the United States by the USACE.

- **Wetland 4 – BVW, Waters of the United States** (local, State, and Federal jurisdiction) is a large forested swamp located approximately 30 ft (9.1 m) east of Higgins Crowell Road in Yarmouth. The wetland has an open understory consisting of sweet pepperbush, highbush blueberry and Sphagnum mosses and canopy dominated by red maple. The wetland is defined by an obvious topographic break in slope. A headwall with a partially buried culvert is located on the wetland's edge, adjacent to the roadway, but does not appear to be functioning. Wetland 4 is regulated as BVW and has a 100 ft (30.5 m) Buffer Zone under the Massachusetts WPA, and a 50 ft (15.2 m) No-Build Zone and 35 ft (10.7 m) Vegetated Buffer under the Yarmouth WPR. This wetland is regulated as Waters of the United States by the USACE.

- **Wetland 5 – BVW, Bank, Waters of the United States** (local, State, and Federal jurisdiction) is located on the west side of Higgins Crowell Road in Yarmouth and is separated from the road by a strip of upland dominated by pitch pine and sheep laurel (*Kalmia angustifolia*). The wetland consists of a roughly circular wet meadow dominated by asters, little bluestem (*Schizachyrium scoparium*), rushes (*Juncus* spp.), umbrella-sedges (*Cyperus* spp.), St. John's wort (*Hypericum* spp.), cranberry (*Vaccinuium oxycoccos*), spike rush (*Eleocharis* spp.), and sundews (*Drosera* spp.). The east side of the wet meadow area abuts a 30 ft (9.1 m) wide shrub swamp, densely vegetated with green briar, inkberry, highbush blueberry, pitch pine, and fetterbush. A manmade intermittent channel on the west side of the wetland flows west into Hawes Run. Both the wetland and intermittent channel were dry at the time of inspection in December 2002. The USGS map shows the wet meadow as an open waterbody meeting the 10,000 square ft (929 $m^2$) size requirements for a Pond under the Massachusetts WPA. However, observations of the area dry during non-drought periods indicates that it does not meet the definition of Pond under the Massachusetts WPA (310 CMR 10.04) or the Yarmouth WPR (Section 1.04). Wetland 5 is regulated as BVW and Bank with a 100 ft (30.5 m) Buffer Zone under the Massachusetts WPA. Under the Yarmouth WPR, a 50 ft (15.2 m) No-Build Zone and 35 ft (10.7 m) Vegetated Buffer is established from the wetland boundary. Wetland 5 is regulated as Waters of the United States by the USACE.

  Wetland 5 is located within PH 40 and EH 188 a known area to contain the Plymouth Gentian (*Sabatia kennedyana*) a species of special concern according to NHESP.

From Willow Street in Yarmouth, the onshore transmission cable system route leaves the roadway and extends west and south for approximately 2 miles (3.2 km) along the NSTAR Electric ROW to the Barnstable Switching Station. One freshwater vegetated wetland area bordering the south shore of Long Pond in Yarmouth is present along the existing ROW immediately west of Willow Street.

- **Wetland 6 – BVW, Bank, LUWW, Waters of the United States** (local, state, and Federal jurisdiction) consists of Long Pond, which is situated on the northern edge of the ROW just west of Willow Street. The pond contains open water, surrounded by a fringe of emergent marsh and shrub swamp dominated by highbush blueberry, sweet pepperbush, swamp azalea, and leatherleaf (*Chamaedaphne calyculata*). The wetland is located at the base of a steep slope; however, many of the wetland plants, including swamp azalea and sweet pepperbush, are growing significantly upslope. Therefore, the boundary of the wetland was delineated using evidence of hydrology and hydric soils, under criteria established by the MassDEP. Wetland 6 is regulated as BVW, Bank, and LUWW and has a 100 ft (30.5 m) Buffer Zone under the Massachusetts WPA, and a 50 ft (15.2 m) No-Build Zone and 35 ft (10.7 m) Vegetated Buffer under the Yarmouth WPR. This wetland is regulated as Waters of the United States by the USACE.

  Wetland 6 is located within PH 88 and EH 187 a known area to contain the Plymouth Gentian a species of special concern according to NHESP. Wetland 6 is also identified as Coast Plain Pondshore Natural Community according to the NHESP Natural Communities GIS data layer. The MassGIS data layer currently has 92 different Coastal Pain Pondshores mapped. Coast Plain Pondshore vegetation has zonation that is correlated with a flooding regime (Swain and Kersley, 2001). Coastal Plain Pondshores typically have a characteristic zonation pattern from dry to waterline, as follows:

  - Upland oak forest;
  - Shrub border dominated by highbush blueberry (*Vaccinium corymbosum*) associated with sweet pepperbush (*Clethra alnifolia*), and green briar (*Smilax rotundifolia*);
  - Emergent exposed pondshore dominated by coastal plain flat-topped goldenrod (*Euthamia tenuifolia*), pondshore rush (*Juncus pelocarpus*), rose coreopsis (*Coreopsis rosea*) and golden pert (*Gratiola aurea*), with beaksedge (*Rhynchospora* spp.), lance-leaf violet (*Viola lanceolata*), and dwarf St. John's-wort (*Hypericum mutilum*);
  - Semi-permanently flooded zone characterized by one or more of the following: bayonet rush (*Juncus militaris*), spike-sedge (*Eleocharis* spp.), pipewort (*Eriocaulon aquaticum*); and
  - Hydromorphic rooted vegetation in deeper water including yellow water-lily (*Nuphar variegata*), white water-lily (*Nymphaea odorata*), and Robbins' spike-sedge (*Eleocharis robbinsii*).

### 4.2.2 Coastal and Intertidal Vegetation

Coastal wetlands as classified under the Massachusetts Wetland Protection Act were identified along the sections of the proposed submarine transmission cable route inside the state territorial limit in Lewis

Bay to the proposed landfall location at New Hampshire Avenue in Yarmouth, and the coastal portions of the onshore transmission cable system route abutting Lewis Bay. The proposed landfall location is a rectangular embayment beach surrounded by a concrete headwall. Residences with associated yards are located directly adjacent (east and west) to the rectangular embayment, and their ocean frontage is fortified by concrete retaining walls and riprap.

#### *4.2.2.1 Flora*

The shoreline at the New Hampshire Avenue landfall is a concrete revetment. The landfall location is devoid of flora. Residences with associated yards are located directly adjacent (east and west) to the rectangular embayment, and their ocean frontage is fortified by concrete retaining walls and riprap. There are no known significant populations of coastal flora present at the proposed landfall location.

#### *4.2.2.2 Barrier Islands, Beaches, and Dunes*

The shoreline at the landfall does not serve as a sediment source for coastal beaches or coastal dunes; however, it provides a vertical buffer that is significant to storm damage prevention and flood control. There are two coastal beaches associated with this proposed action. One is Coastal Beach 1 in which the proposed transmission cable system comes ashore. The other is Coastal Beach 2, which is located approximate 60 ft (18.3 m) east of the proposed transmission route and is known as Englewood Public Beach.

- **Coastal Beach 1** (state and local jurisdiction) is defined under the Massachusetts WPA as unconsolidated sediment subject to wave action, tidal and coastal storm action that forms the gently sloping shore of a body of water. Coastal Beach extends from the mean low water line landward to the coastal bankline or seaward edge of existing manmade structures. Coastal Beach 1 is a gently sloping, sandy area that extends from mean low water line to the concrete revetment that comprises Coastal Bank at the proposed landfall location. The Massachusetts WPA and the Yarmouth WPR establish a 100 ft (30.5 m) Buffer Zone to Coastal Beach. In addition, the Yarmouth WPR prohibit structures within 50 ft (15.2 m) of Coastal Beach and establish a 35 ft (10.7 m) Vegetated Buffer.

- **Coastal Beach 2** (state and local jurisdiction) is Englewood Public Beach, located approximately 60 ft (18.3 m) east of New Hampshire Avenue. The beach extends from the mean low water line west to the edge of a paved parking lot adjacent to New Hampshire Avenue. The Massachusetts WPA and the Yarmouth WPR establish a 100 ft (30.5 m) Buffer Zone to Coastal Beach. In addition, the Yarmouth WPR prohibit structures within 50 ft (15.2 m) of Coastal Beach and establish a 35 ft (10.7 m) Vegetated Buffer.

#### *4.2.2.3 Brackish and Saline Wetlands*

The transmission cable system corridor intersects coastal wetland resources and their buffer zones, some of which are jurisdictional under the Massachusetts WPA and some through the CWA under the USACE. Jurisdictional and coastal wetland resource areas observed to occur between the 3.5 mile (5.6 km) limit and the proposed landfall location, (see Table 4.2.2-1), include the following:

- **Salt Marsh 1** (state and local jurisdiction) is defined as vegetated wetlands located in the intertidal zone dominated by herbaceous plants adapted to varying levels of salinity. Salt Marsh 1 is located approximately 200 ft (61 m) west of the proposed landfall location, between Lewis Bay and Shore Road in Yarmouth. This salt marsh is vegetated by poison ivy (*Toxicodendron radicans*), salt meadow cordgrass (*Spartina patens*), rushes (*Juncus* spp.), and seaside goldenrod (*Solidago sempervirens)*. This salt marsh is positioned between the residences at 43 and 37 Shore Drive. The Massachusetts WPA and the Yarmouth WPR establish a 100 ft (30.5 m) Buffer Zone to Salt Marsh. In addition, the Yarmouth WPR prohibit structures within 50 ft (15.2 m) of Salt Marsh and establish a 35 ft (10.7 m) Vegetated Buffer.

- **Salt Marsh 2** (state and local jurisdiction) is located approximately 85 to 120 ft (26 to 36.6 m) west of the proposed transmission cable system route on New Hampshire Avenue. It is bordered by residences to the east and west, Shore Road to the south, and Broadway to the north. According to the Cape Cod Atlas of Tidally Restricted Salt Marshes (2001), a 12-inch (30.5 cm) wide culvert connecting this salt marsh to Lewis Bay is consistently clogged, causing regular tidal flooding over Shore Road between Salt Marsh 1 and Salt Marsh 2 (Cape Cod Commission, 2001). Salt Marsh 2 is vegetated by high tide bush (*Iva frutescens*), bayberry (*Morella caroliniensis*), poison ivy, salt meadow cordgrass, rushes, and seaside goldenrod. A defined channel is visible in the center of the salt marsh. The Massachusetts WPA and the Yarmouth WPR establish a 100 ft (30.5 m) Buffer Zone to Salt Marsh. In addition, the Yarmouth WPR prohibit structures within 50 ft (15.2 m) of Salt Marsh and establish a 35 ft (10.7 m) Vegetated Buffer.

- **Navigable Waters of the United States** (Federal jurisdiction) are defined as waters seaward of the high water line of navigable waters under Section 10 of the Rivers and Harbors Act of 1899. Navigable Waters of the U.S. encompass and extend beyond the state-regulated Land Under the Ocean. Since the landward boundary of navigable waters of the U.S. extends to the MHW elevation, this resource area partially overlaps with the Federally-regulated Waters of the United States and State-regulated Land Subject to Tidal Action, Land Containing Shellfish, and Coastal Beach.

- **Waters of the United States** (Federal jurisdiction) are defined as waters seaward of the highest annual tide line in tidal waters. The seaward limit of jurisdiction extends to the Massachusetts 3.5 mile (5.6 km) limit. When adjacent wetlands are present, such as salt marshes, the limit of jurisdiction extends to the boundary of the wetland. Waters of the United States overlap with the Federally-regulated Navigable Waters of the United States and the State-regulated Land Under the Ocean, Land Subject to Tidal Action, Land Containing Shellfish, Coastal Bank and Coastal Beach. This resource area also includes Salt Marsh 1 and 2, described below. It should be noted that although Salt Marsh is identified herein there are no direct impacts to Salt Marsh from the proposed action, as presented above.

- **Land Under the Ocean** (State and local jurisdiction) is defined under the Massachusetts WPA as the land extending from the mean low water line seaward to the boundary of the municipality's jurisdiction, and includes land under estuaries. Land Under the Ocean along the route consists of Lewis Bay and portions of Nantucket Sound within the 3.5 mile (5.6 km) state territorial limit. All work proposed in Land Under the Ocean includes Nearshore Areas, which extend to the municipality's jurisdiction but not beyond the point where the land is 80 ft (24.4 m) below the level of the ocean at mean low water. Most of the proposed work in Land Under the Ocean would be within the Town of Yarmouth; however, a small portion of the work would occur within the Town of Barnstable. The Yarmouth WPR establish a 100 ft (30.5 m) Buffer Zone to Land Under the Ocean. The Barnstable Wetlands Protection Ordinance provides no additional regulations for Land Under the Ocean beyond those in the Massachusetts WPA.

- **Coastal Bank** (State and local jurisdiction) is defined as the seaward face or side of any elevated landform, other than a coastal dune, which lies at the landward edge of a coastal beach, land subject to tidal action, or other wetland. The Coastal Bank at the New Hampshire Avenue landfall is a concrete revetment. The Massachusetts WPA and the Yarmouth WPR establish a 100 ft (30.5 m) Buffer Zone to Coastal Bank. In addition, the Yarmouth WPR prohibit structures within 50 ft (15.2 m) of Coastal Bank and establish a 35 ft (10.7 m) Vegetated Buffer.

- **Land Subject to Tidal Action** (State and local jurisdiction) is defined as land subject to the periodic rise and fall of a coastal waterbody, including spring tides. The Yarmouth WPR establish a 100 ft (30.5 m) Buffer Zone to Land Subject to Tidal Action.

- **Land Subject to Coastal Storm Flowage** (State and local jurisdiction) is defined as an area that extends upgradient or landward from the ocean and the ocean's estuaries to a point where the maximum lateral extent of flood water would theoretically terminate based upon the 100-year storm elevation referenced in the latest FIRM. The Land Subject to Coastal Storm Flowage extends approximately 1,100 linear ft (335.3 m) from the shoreline, along the route from the proposed landfall. The 100-year flood elevation varies from 13 ft (4 m) National Geodetic Vertical Datum (NGVD) at the landfall location to 11 ft (3.4 m) NGVD just beyond the intersection of Berry Avenue and Broadway.

  Portions of the area of the proposed action below elevation 13 ft (4 m) NGVD are also within the "V-zone." The V-zone is an area subject to flooding with wave action during a 100-year storm event. In the vicinity of the proposed landfall, the V-zone extends to approximately 300 ft (91.4 m) north of the Coastal Bank.

- **Land Containing Shellfish** (State and local jurisdiction) is located within Land Under the Ocean and Waters of the United States and may be located in Coastal Beach and Salt Marsh. The applicant's research and discussions with the Yarmouth Shellfish Constable (Caia, 2002) indicate that Lewis Bay contains quahogs (*Mercenaria mercenaria*) and soft shell clams (*Mya arenaria*), with some scallops (*Placopectin magellanicus*) and Eastern oysters (*Crassostrea virginica*). Shellfish resources within Lewis Bay are utilized for commercial and recreational shellfishing. The proposed submarine transmission cable route in Lewis Bay crosses a designated recreational shellfish area, but would not cross any privately licensed shellfish areas or grants (Town of Yarmouth Natural Resource Commission's Aquaculture Lease Site Maps and Recreational Shellfish Area Maps dated June 1, 1998 and December 2, 1999). Figure 4.2.2-1 presents MassGIS mapping of shellfish suitability areas that includes the locations of these designated commercial and recreational shellfish areas. Additional information on shellfish resources in Lewis Bay is provided in Section 4.2.5.3 (Benthic and Shellfish Resources).

- **Coastal Watershed Areas** (local jurisdiction) are defined in the Yarmouth WPR as wetland and upland landforms that contribute surface and sub-surface water to the estuaries within the town. These areas are mapped and delineated within a "Water Resources Protection Study" prepared for the Town of Yarmouth (see Figure 4.1.6-1). Conservation Commission jurisdiction is restricted to mapped areas within 300 ft (91.4 m) of a major estuary. Portions of the proposed route are in a mapped Coastal Watershed Area within 300 ft (91.4 m) of Lewis Bay, defined as a major estuary under Section 1.04 of the local regulations.

### *4.2.2.4 Seagrass Beds*

MassDEP mapping and previous geophysical studies were used to identify areas of potential submerged aquatic vegetation (SAV) within the area of the proposed action. Geophysical studies using side-scan sonar of Horseshoe Shoal were completed in 2002, 2003 and 2005. The 2003 geophysical survey included side-scan sonar of the proposed cable route as indicated in Figure 2.1.2-1. MassDEP mapping and geophysical studies indicate that there are three potential SAV areas occurring within the area of the proposed action. Two are mapped in Federal waters beyond the Massachusetts 3.5 mile (5.6 km) limit and are located on Horseshoe Shoal. The other area occurs within the Massachusetts 3.5 mile (5.6 km) limit, near Egg Island in Lewis Bay. The potential seagrass areas were investigated in order to groundtruth the SAV beds, both in terms of characteristics and extent.

The Horseshoe Shoal investigation conducted on July 25, 2006 was performed to address several areas where previous side-scan sonar observations indicated the potential presence of SAV beds. The major goal of this study was to determine the presence or absence of seagrasses, and to qualitatively assess the composition of SAV in these areas of variable side-scan sonar returns (Report No. 4.2.2-1). The Lewis Bay investigation was performed July 1, 2003 to determine the extent of mapped SAV bed in the vicinity of the proposed submarine transmission cable route and to modify the proposed cable route accordingly to avoid direct impacts to SAV near Egg Island (Report No. 4.2.2-2).

The vegetative composition within the Horseshoe Shoal study area was found to consist primarily of attached red (*Grinnellia americana, Dasya pedicellat,* and *Gracillaria tikvahiae*), and green (*Codium fragile* and *Ulva lactuca*) macro-algae, not seagrasses. Of the 20 observation points, only one location included patches of eelgrass (*Zostera marina*). Of the algal species identified, only *C. fragile* is not native to New England waters; however, since its introduction it has rapidly expanded its range, and its presence at depths ranging from emergent tidal pools to depths of -39 ft (-12 m) below MLW (Villalard-Bohnsack, 2003) (Report No. 4.2.2-1).

Many of the macro-algae observed are considered seasonal, with growth beginning in early to mid-summer and disappearance by late August (Hillson, 1982; Kingsburry and Sze, 1997; Villalard-Bohnsac, 2003). Of the species observed, *G. americana* is potentially the most likely responsible for the variable side-scan sonar readings collected during geophysical studies conducted in 2003 and 2005. *G. americana* is a fast growing red alga, with a two- to four-inch-wide blade capable of growing to 19.7 inches (50 cm) in length within a single summer growth season (Hillson, 1982). For additional details on the methodology and results, see Report No. 4.2.2-1.

Several small patches of eelgrass (*Zostera marina*) were found at location T2B during the July 25, 2006 survey. This is located in the northern end of the western potential SAV bed per the 2003 and 2005 surveys in the Horseshoe Shoal area. The patches ranged in size from 3 to 9 ft (1 to 3 m) in diameter (due to the limited field of view of the camera system, size estimates are approximations) (Report No. 4.2.2-1). No other seagrass was observed during the survey.

The MassDEP Wetlands Conservancy Program has mapped submerged aquatic vegetation (SAV) beds one quarter acre or larger in size along the coast using aerial photography, GPS, and field verification. Mapping was completed in 1995 and 2001. The 2001 data were published in February 2006 and made available on the MassGIS website. The MassGIS mapping is shown on the benthic habitat map (Figure 4.2.2-1). Based upon the MassDEP mapping, one SAV bed has been mapped within Lewis Bay, located to the west of Egg Island in the Town of Barnstable. This SAV bed was also confirmed during the geophysical and geotechnical investigations conducted in 2001 and 2003. Based on a December 2002 telephone conversation with Mr. Charles Costello of the MassDEP Wetlands Conservancy Program, the applicant indicates that the mapped SAV bed had not changed much in size between 1995 and 2001. According to the MassGIS website, MassDEP mapping of the eelgrass data are conducted on a 5-year cycle. The next mapping was scheduled for 2006-2007, but results are not yet available.

The Lewis Bay SAV was identified by free diving and visual observations from a small research vessel. The diver search was conducted using a 100 ft (03.5 m) search line that was marked every 10 ft (3 m) for reference. The area was swept in a 360 degree pattern at 10 ft (3 m) increments out to 100 ft (30 m). It was determined that the SAV was eelgrass (*Zostra marina*). The extent of the mapped eelgrass bed is shown in Report No. 4.2.2-2. As presented in Tables 1 and 2 of Report No. 4.2.2-2, the divers observed that the seagrass tended to occur in small patches ranging in diameter from 3 to 20 ft (1 m to 6.3 m). Based on the field survey results, the submarine transmission cable system would be no closer than 70 ft (21.3 m) to the western edge of the eelgrass bed located near Egg Island.

## 4.2.3 Terrestrial and Coastal Faunas Other than Birds

The project components that occur on land are restricted to the transmission cable to be installed within and adjacent to roadways, along an existing electric transmission ROW, and a minor amount of work at an existing substation. Therefore, terrestrial fauna are those species likely to inhabit the various vegetative communities adjacent to the roadways, particularly in areas located away from development and busy roadway intersections. However, the area of the proposed action within the paved roadways and roadway shoulders is not expected to provide nesting, breeding, feeding, or overwintering habitat for wildlife species. As a result of "edge effect," the maintained NSTAR Electric ROW is likely to provide habitat for a diverse, but not unique, wildlife community.

### *4.2.3.1 Mammals*

Mammals that could use the terrestrial cable corridor would be typical of southeastern Massachusetts. These mammals would include but not be limited to white-tailed deer (*Odocoileus virginianus*), coyote (*Canis latrans*), red fox (*Vulpes vulpes*), Virginia opossum (*Didelphis virginiana*), woodchuck (*Marmota monax*), striped skunk (*Mephitis mephitis*), common raccoon (*Procyon lotor*) and various rodents. Many of these species would use the NSTAR ROW and the woodland adjacent to some of the roadway portions of the proposed buried line for hunting, browsing, and nesting habitat.

#### 4.2.3.1.1 Bats

Although resident and migrant bat populations have been documented on the Islands, it remains unclear as to how they travel to and from the islands; however, it is possible that they may cross Vineyard Sound and/or Nantucket Sound (DeGraaf and Yamasaki, 2001; Buresch, 1999).

Species of bat that currently or historically occur in Massachusetts include big brown bat (*Eptesicus fuscus*), little brown bat (*Myotis lucifugus*), Northern long-eared bat (*Myotis septentrionalis*), Indiana bat (*Myotis sodalist*) (last recorded in 1939; Federally and State Endangered), small-footed bat (*Myotis leibii*) (known to occur only in Hampden County; species of conservation concern), Eastern pipistrelle (*Pipistrellus subflavus*), silver-haired bat (*Lasionycteris noctivagans*) (species of conservation concern), red bat (*Lasiurus borealis*) (species of conservation concern), and hoary bat (*Lasiurus cinereus*) (species of conservation concern). The majority of these species occur statewide in Massachusetts, however, no state or federally-listed threatened or endangered bat species occur in southeastern Massachusetts. A total of twenty three hibernacula are known to support wintering bats in Massachusetts. Eleven are anthropogenic hibernacula (i.e., mines) and twelve are naturally occurring caves (MDFW, 2005). The majority of hibernacula are located in the western portion of the state in Berkshire County. Known hibernacula are located in the Townships of Charlemont, Cheshire, Chester, Egremont, Lanesborough, New Ashford, New Marlborough, North Adams, Pepperell, Rowe, Sturbridge, and West Stockbridge. There are no known winter hibernacula located in Barnstable, Dukes, or Nantucket Counties. The furthest southeastern known hibernaculum in Massachusetts is located in the Township of Sturbridge in Worcester County.

Of the seven species occurring in the region, the silver-haired bat, eastern red bat, and hoary bat (tree-roosting bats) are considered long-distance migrants, whereas the big brown bat, northern myotis, eastern pipistrelle, and little brown myotis do not typically travel long distances between their hibernacula and summer ranges (Whitaker and Hamilton, 1998). Although home ranges have not been described for northern myotis and little brown myotis, eastern pipistrelles and big brown bats are thought to travel no more than 50 miles (80 km) between hibernacula and summer ranges (DeGraaf and Yamasaki, 2001). Bats in southeastern Massachusetts either hibernate or migrate south during the winter, and are generally active between late April and early October, depending upon the temperature and weather conditions. Long-distance migratory bats travel south to their winter ranges (southern United States) between August and early October, and return during April and May. Little is known about the migratory behavior of the tree-roosting bats. However, museum records of migratory bats in North America suggest some tendency to migrate along the Pacific and Atlantic coasts, especially during the fall (Cryan, 2003).

Species such as big brown bats, *myotis* species, and eastern pipistrelle make small scale movements in April and May, and August and September between summer breeding areas and winter hibernacula. Most of these species travel 50 miles (80 km) or less, however, some dispersals are as far as 310 miles (500 km) (England et al., 2001). The long-distance migratory bats over-winter in southern North America. Silver-haired bats winter in mild coastal climates as far north as New York (England et al., 2001). Red-bats winter in Arkansas, Missouri, Kentucky, Tennessee, West Virginia, Virginia, North Carolina, the Gulf States, and northern Mexico (England et al., 2001). Hoary bats winter in coastal areas from South Carolina to central Florida, the Gulf States west to Texas, and south to northern Mexico (England et al., 2001). Their migratory movements are usually associated with the passage of cold fronts. Most migrants arrive at breeding grounds by May or June, and depart for winter habitats in August and September.

Although bats are terrestrial species and are generally not associated with saline habitats, saltwater crossings have been documented for migratory tree bats. Occasional observations of silver-haired, eastern red bats and hoary bats on ships at sea and offshore islands such as Bermuda confirm that these species are able to travel long distances over water (Cryan, 2003). A more recent paper summarizes incidental observations of bats made at Southeast Farallon Island, 19.8 miles (32 km) south of Point Reyes, California, recorded between 1968 and 2005, which indicate that migratory hoary bats use the island as a stopover point during fall migration periods, occasionally forming migratory flocks (Cryan and Brown 2007). Additional published records of bats over coastal and marine habitats are limited and generally out-dated, but include the following. Migratory bats (eastern red, silver-haired, and hoary bats) were reported over coastal and marine areas in the fall during late-1800s in the vicinity of Highland Light, a near-shore lighthouse near North Truro, on Eastern Cape Cod (Miller, 1897). In 1907, what were believed to be silver-haired bats were observed roughly 5 miles (8 km) offshore, flying just above the water's surface toward the shoreline of Staten Island before sunrise. During October of the same year, bats that were presumed to be migrants that had crossed Long Island Sound were observed roosting under beach cliffs along the north shore of Long Island (Murphy and Nichols, 1913). In 1919, an eastern red bat was observed circling a ship that was out of view of land, an hour after sunrise. The bat was believed to be following a southern migration path over water, and had not merely been blown offshore due to weather conditions (Nichols, 1920). In September 1920, approximately 100 eastern red and silver-haired bats landed on a ship located 20 miles (32.1 km) off the coast of North Carolina (Thomas, 1921). In 1949, roughly 200 bats were seen flying around a ship 65 miles (104 km) offshore (85 miles [136.7 km] southwest of Nantucket Island) (Carter, 1950). There were multiple records of bats circling then coming to roost on ships that were roughly 100 miles (161 km) or more offshore (Mackiewicz et al., 1956; Griffin, 1940; Norton, 1930).

These observations indicate that bats, particularly the migratory tree-roosting species, frequently undertake long distance movements over water during certain times of year. Whereas no studies have occurred to track migration patterns of bats along the east coast, it is possible that certain species of migratory bats follow migration corridors along the Atlantic coast, in a manner similar to those followed by many migratory birds. However, historic observations of bat migration should be interpreted with caution. The observations of groups of hundreds of migrating bats seen offshore nearly one hundred years ago is likely a reflection of historically much more abundant bat populations. Though large flocks of over one hundred individuals of migratory red bats could once be observed, more recent observations have reported no more than 15 individual migrants at a time (England et al., 2001). The populations of many species of bats have suffered notable declines, including species that were once considered common (England et al., 2001).

No surveys specific to bats were conducted in association with the proposed action, and little is known about the frequency with which bats fly over water bodies such as Nantucket Sound. All seven species of bats found in southeastern Massachusetts were confirmed on Martha's Vineyard, and Nantucket is within the theoretical range of four species (little brown myotis, silver-haired bat, eastern red bat, and hoary bat) (DeGraaf and Yamasaki, 2001; Buresch, 1999). Little information is available of bat use of Nantucket Sound. Bats do inhabit islands in Nantucket Sound; therefore, over-water crossings do occur. An acoustical detection and netting study conducted in spring through fall 1997 and 1998 documented silver-haired bat, red bat, hoary bat, Eastern pipistrelle, big brown bat, little brown bat, and Northern long-eared bat on Martha's Vineyard. Data indicated that *myotis* species may be using Martha's Vineyard as a stopover point during spring dispersal: Higher levels of *myotis* acoustic activity detected in the spring and early summer was believed to be associated with seasonal dispersal activity (Buresch, 1999). These high detection levels did not occur within the fall. This was believed to be a result of a longer, more continual fall migration (Buresch, 1999). Surveys were also conducted at the Camp Edwards portion of MMR on Cape Cod in 1999 and 2000, and documented the presence of four bat species: the big brown bat, eastern red bat, northern myotis, and the eastern pipistrelle (Massachusetts Army National Guard, 2001).

Although all species of bats present in southeastern Massachusetts are theoretically capable of crossing Nantucket Sound and have been documented on Martha's Vineyard, the migratory tree bats (eastern red bat, silver-haired bat, and hoary bat) are the most likely species to travel through the area of the proposed action, as they are stronger fliers and have demonstrated ability to travel over large bodies of water. These species would be expected to be present in the area of the proposed action only during spring and fall migrations. No bat species are expected to forage within the area of the proposed action, and bats would likely pass through the area only during migration and when traveling from the mainland to island habitats.

#### 4.2.3.2 Reptiles and Amphibians

The amphibians and reptiles in the assessment area would be typical for the region including but not limited to the following species; pickerel Frog (*Rana palustris*); American bullfrog (*Rana catesbeiana*);

wood frog (*Rana sylvatica*); eastern American toad (*Bufo americanus americanus*); common garter snake (*Thamnophis sirtalis*); snapping turtle (*Chelydra serpentine*); painted turtle (*Chrysemys picta*) northern two-lined salamander (*Eurycea bislineata*); eastern Red-backed Salamander (*Plethodon cinereus*); eastern newt (*Notophthalmus viridescens*). The majority of the reptile and amphibian species would use the wetlands located adjacent to the proposed buried transmission cable system as breeding, foraging, and nesting habitat. The maintained utility ROW is more than likely to be traveled across by amphibians and reptiles migrating to the wetlands located along the ROW. There are numerous insect populations common to the region that would feed in the herbaceous plants that would be growing in the cleared ROW. These insects provided food for the insectivorous reptile and amphibians.

#### 4.2.3.3 Freshwater Fish

The proposed action has only one crossing where the presence of freshwater fish is a concern. The transmission cable crosses Thornton Brook, designated as intermittent. The proposed transmission corridor crosses Thornton Brook just after it exits Jabinettes Pond. Jabinettes Pond discharges into Thornton Brook, which appears to flow west and crosses beneath Higgins Crowell Road via a culvert. This stream channel was observed to be completely dry during the field reviews in October 2001 and December 2002 and the presence and the potential species of fish that could be impacted could not be assessed.

#### 4.2.3.4 Invertebrates

The invertebrate population in or near the proposed on-land transmission cable system route are typical of southeastern Massachusetts, consisting of, but not limited to, species such as:

- Red-legged locust (*Melanoplus femur-rubrum*)
- Field cricket (*Gryllus pennsylvanicus*)
- Meadow spittlebug (*Philaenus spumarius*)
- Eastern yellow jacket (*Vespula maculifrons*)
- Honey bee (*Apis mellifera*)
- American bumblebee (*Bombus pennsylvanicus*)
- Wood ticks (*Dermacentor* spp.)
- Black-legged ticks (*Ixodes* spp.)
- Daring jumping spider (*Phidippus audax*)
- Wolf spiders (*Pardosa* spp.)
- American house spider (*Achaearanea tepidariorum*)
- European earwig (*Forficula auricularia*)
- Convergent lady beetle (*Hippodamia convergens*)
- Black blister beetle (*Epicauta pennsylvanica*)
- Little black ant (*Monomorium minimum*)
- Rose weevil (*Rhynchites bicolor)*
- Eastern dobsonfly (*Corydalus cornutus*)
- Tent caterpillars (*Malacosoma* spp.)
- Gypsy moth caterpillar (*Lymantria dispar*)
- Woolly bear caterpillar (*Isia isabella*)
- Fall webworm (*Hyphantria cunea*)
- Monarch butterfly (*Danaus plexippus*)
- Earthworm (*Lumbricidae* spp.)
- Night crawler (*Lumbricus terrestris*)
- House mosquito (*Culex pipiens*)

According to the NHESP there are threatened or endangered invertebrate species along the proposed route. These state-listed T&E species are:

(1) Comet darner (*Anax longipes*), a species of special concern;
(2) New England bluet (*Enallagma laterale*), a species of special concern; and
(3) Water-willow stem borer (*Papaipema sulphurat*a), a threatened species.

### 4.2.4 Avifauna

Avian resources that are likely to occur in the area of the proposed action are protected under the Migratory Bird Treaty Act (16 USC §§ 703-712) and in some cases, the Endangered Species Act. Additionally, Federal projects are subject to Section 7 of the ESA (1973, as amended). Each Federal agency is required to ensure that any authorized project is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of critical habitat (7 USC § 136; 16 USC § 460 et seq. [1973]), as discussed in Section 4.2.9. Executive Order 13186 "Responsibilities of Federal Agencies to Protect Migratory Birds" (January 10, 2001) requires that Federal agencies evaluate the effects of agency actions on migratory birds.

Nantucket Sound is recognized as a regionally significant locale for waterbirds (Veit and Peterson, 1993). The Sound is located within the Atlantic flyway, and its position along the flyway is ideal for attracting thousands of waterbirds during migration. The Sound's location, the configuration of the surrounding landscape, the mixture of contributing waters, and the regional climate combine to attract many species of waterbirds year-round. To evaluate the potential effects of the proposed action, it is necessary to first understand the abundance and distribution of avian resources and their use of the area of the proposed action.

In Nantucket Sound, specific groups of species occur in various habitats at different times of the year. For this description, species are divided into three groups: terrestrial birds, coastal birds, and marine birds. Terrestrial birds are species that spend the majority of their time on land and may cross the area of the proposed action but do not linger or forage there. Coastal birds include shorebirds and wading birds that may cross the area of the proposed action but most likely do not linger or forage there. Marine birds are defined as those species that spend the majority of their time in Nantucket Sound away from shore and may be regular visitors to the Project Area for purposes of feeding or resting. T&E bird species are discussed in Section 4.2.9.

The following sections summarize the distribution, numbers, seasonality, and behavior of the various species groups based on pre-existing information and results of surveys conducted by the applicant and Massachusetts Audubon Society (MAS). From March 2002 through September 2006, aerial, boat, and radar surveys were conducted by the applicant. Additionally, the MAS conducted aerial and boat surveys from August 2002 through September 2004. Survey efforts attempted to estimate avian occurrence and distribution within Nantucket Sound, primarily in relationship to Horseshoe Shoals where the project is proposed. Between the two efforts, survey methods were similar but not identical; therefore, direct comparisons between the two data sets were made with caution. Table 4.2.4-1 shows the studies used during preparation of this description.

A Preliminary Avian Risk Assessment was conducted (Report No. 4.2.4-1). The initial assessment recognized that available information on bird use of Horseshoe Shoal is limited. The assessment indicated that studies should be directed to investigate bird use of the three shoal areas in Nantucket Sound and to estimate the potential effects of wind turbines on resident and migrant birds. The assessment specifically identified the need to understand waterbird abundance and distribution in Nantucket Sound. Based on this recommendation, terns, seaducks, seabirds, and diving birds were intensively studied throughout the year from March 2002 through March 2006, including aerial, boat, and radar surveys. Data was collected throughout Nantucket Sound, both inside and outside the area of the proposed action. Focal points of the survey efforts were three possible alternative sites: Horseshoe Shoal, Monomoy-Handkerchief Shoal, and Tuckernuck Shoal.

The applicant and MAS collectively flew 125 systematic aerial surveys to document avian species and distributions in Nantucket Sound (see Table 4.2.4-2 and Table 4.2.4-3). These surveys included parallel transects aligned north to south throughout the Sound (Report No. 4.2.4-2; Perkins et al., 2004). Surveys were conducted during the daytime throughout different seasons from March 2002 through March 2006. Surveys were flown during the tern breeding and fall staging periods. Surveys also occurred throughout the fall through early spring when large concentrations of wintering sea ducks and waterbirds congregate in Nantucket Sound. The applicant flew 46 aerial surveys from March 2002 through February 2004 and MAS flew 79 aerial surveys from August 2002 through March 2006 (Report No. 4.2.4-2). The applicant and MAS also conducted boat surveys to complement the aerial surveys and to make observations of avian behavior (e.g., traveling, feeding, resting), and to estimate flight heights when possible. A total of 17 boat surveys were conducted from May 2002- March 2005 during the same study periods as the aerial surveys and covered a similar area but generally did not follow the predetermined transects established for the flights. Observations were recorded on species presence, as well as their numbers, altitude, direction of flight, and other behaviors.

The applicant also conducted radar surveys during the spring and fall migration periods. The spring surveys were conducted from a jack-up lift barge located at the southern end of Horseshoe Shoal and the fall surveys were conducted from a cliff on Cape Pogue, on the northeastern tip of Martha's Vineyard. Horseshoe Shoal is located within the area of the proposed action while the Cape Pogue site is located approximately 10 miles (16.1 km) southwest of the area of the proposed action.

A summary of the Nantucket Sound radar surveys is provided in Table 4.2.4-4. The average flight heights documented over Nantucket sound are lower than those documented for nocturnal radar surveys conducted in terrestrial ecosystems. Additionally, the season mean nocturnal passage rates were lower over Nantucket Sound than at the majority of land-based radar sites. The difference in radar data between inland sites and in Nantucket Sound are likely the result of the different radar systems used. Inland radar surveys are typically conducted with X-band radar systems because they are capable of detecting small targets such as birds, bats, and even insects. These systems are also operated at a range setting of 0.86 miles (1.4 km) which is much smaller than the range settings used at Nantucket Sound. Operation at a smaller range setting allows for accurate distinction between individual targets. The low passage rates observed at Nantucket sound are likely an artifact of the TracScan (S-band) radar used to determine target position, speed, heading (horizontal data). As explained above, TracScan is not as effective as X-band radar for distinguishing between individual targets that may be flying close together or in flocks, especially using long range settings. Therefore, it is expected that fewer individual targets would have been identified using the TracScan (S-Band) radar system. The seasonal results of the Cape Wind radar surveys were significantly different than inland sites and are likely due to the combination of factors described above.

### *4.2.4.1 Terrestrial Birds*

This section describes the landbird species that may cross the area of the proposed action but do not linger or forage there.

#### 4.2.4.1.1 Raptors (hawks, owls, eagles, falcons, etc.)

Except for an occasional osprey (*Pandion haliaetus*) and, perhaps, peregrine falcon (*Falco peregrinus*), these birds are not likely to be present at Horseshoe Shoals except by accident, when they are blown offshore or off course in storms, and on rare occasions during migration. There are no topographic features (such as shorelines or shortest crossings) that funnel such migrants to the area. A total of eight ospreys were observed during the boat surveys on August 15 and 22, 2002, and September 12, 2003, (Report No. 4.2.4-3 and Report No. 4.2.4-4). All were observed just offshore south of Falmouth, less than 1 mile (1.6 km) from the shore, and none were observed in the Horseshoe Shoal study areas. Osprey were observed foraging at a height of less than 50 ft (15.2 m), which is typical of their foraging behavior although they are known at times to forage from over 100 ft (30.5 m). Osprey likely forage in Lewis Bay, in proximity to the proposed submarine transmission cable route for the proposed action. No peregrine falcons were observed in the study area during any of the 2002 to 2005 surveys of Nantucket Sound.

#### 4.2.4.1.2 Other Landbirds – Migration

Large numbers of migrating landbirds pass over Horseshoe Shoal at a wide range of altitudes during autumn and spring (April through May and September through October, respectively). They are known to travel over a broad front rather than in narrow streams, but numbers flying over Nantucket Sound in both spring and fall are much lower than over the mainland to the northwest (Nisbet and Drury, 1967). Despite this, numbers estimated to migrate through Nantucket Sound are estimated to be in the millions (Report No. 4.2.4-1).

Geo-Marine, Inc. (GMI) conducted radar surveys for the applicant during four migration seasons to measure passage rates and flight height for both diurnal and nocturnal bird activity (Table 4.2.4-4). Surveys were conducted in spring and fall 2002 (Report No. 4.2.4-5), fall 2005 (Report No. 4.2.4-6), and spring 2006 (Report No. 4.2.4-7). The spring surveys were conducted from a jack-up lift barge located at the southern end of Horseshoe Shoal and the fall surveys were conducted from a cliff on Cape Pogue, on the northeastern tip of Martha's Vineyard. Horseshoe Shoal is located within the area of the proposed action while the Cape Pogue site is located approximately 10 miles (16.1 km) southwest of the area of the proposed action.

The radar surveys were conducted using two marine radars simultaneously 24 hours a day. Although surveys were targeted for continual operation there were some periods when data was not collected due to equipment malfunctions. An S-band radar was operated to detect targets within a range of 4.6 miles (7.4 km) during the spring and fall 2002, 6.9 miles (11.1 km) during the fall 2005, and 4.6 miles (7.4 km) during the spring 2006. An X-band radar was operated to document the vertical distribution of targets within a range of 1.7 miles (2.8 km) in altitude and 0.9 miles (1.4 km) downrange. The S-band radar operated horizontally and detected the abundance of targets and their flight direction as they passed through the radar's view while the X-band radar detected the targets flight heights as well as the percentage of targets flying below the height of the proposed turbines.

The results of the radar surveys conducted within the area of the proposed action show some consistent trends. The median flight heights observed during the day were lower than at night across all seasons and years. Another trend observed is that a greater percentage of targets were observed flying at altitudes below the proposed maximum turbine height during the day than at night. These trends are typical because the majority of nocturnal migrants are neotropical songbirds whose flight heights over land are typically at higher altitudes than waterbirds that typically migrate during the day.

Due to variation in bird populations and weather conditions some variation in the passage rate, or abundance, of birds was observed between seasons. For example, both night and day time passage rates were relatively consistent during the first three seasons but increased significantly during the spring 2006 survey. This may be the result of an increased survey effort during this time period. The spring 2006 survey included the entire time frame during which many birds in the northeast are known to migrate and several more nights of optimal migration conditions, and migrant abundance, could have been documented that season.

Very few songbirds or other similar passerines were observed during the visual surveys in the study area. None were observed during the aerial surveys, and only three individuals (two swallows and one American goldfinch) were observed during the boat-based surveys (Report No. 4.2.4-3 and Report No. 4.2.4-4). These results were expected, since most songbirds migrate at night and few would be expected to be found in the area of the proposed action during non-migratory, daytime activities. However, the small size of these birds means that they may be easily missed, and boat- or aerial-based visual observations are unreliable indicators of numbers passing through the area.

### *4.2.4.2 Coastal Birds*

This section describes the coastal bird species that may cross the area of the proposed action but most likely do not linger or forage there, other than at the transmission cable landfall area. Piping plover (*Charadrius melodus*) is a federally-threatened species, and is discussed in more detail in Section 4.2.9 and the BA in Appendix G.

#### 4.2.4.2.1 Shorebirds (sandpipers, plovers, etc)

Shorebirds are most numerous in the area as transients during migration when the large areas of sand and mud near North Monomoy provide important staging areas of internationally recognized importance. Much smaller numbers of shorebirds occur at other sites around Nantucket Sound. Fewer numbers of shorebirds are summer residents in the area. Only a few shorebirds were observed during surveys for the proposed action. It is possible that some shorebirds occasionally fly across the area of the proposed action, from one side of the Sound to another, but no such observations have been recorded, and sightings of shorebirds on beaches do not suggest any concentrated flightlines through the area of the proposed action.

Small numbers of three species/groups of shorebirds were observed during the aerial and boat surveys, including an American oystercatcher *(Haematopus palliatus)* in July, 2003 on the shoreline of Muskeget Island (Report No. 4.2.4-8). One red knot (*Calidris canutus*) and six unidentified sandpipers (*Calidris* spp.) were observed off Cape Poge during boat-based field surveys and 20 dunlins (*Calidris alpine*) were observed on Muskeget Island during an aerial survey in October 2002 (Report No. 4.2.4-9).

Migrating shorebirds typically climb rapidly when departing staging areas and are likely to fly over the Horseshoe Shoal area at high altitudes in the spring and fall, although they may fly at lower altitudes while descending to stopover sites such as Monomoy Island (Veit and Petersen, 1993). Identification of targets by radar is not definitive, but many shorebirds are thought to fly from New England directly to South America. It is not unreasonable to suspect that flights of shorebirds from Monomoy would pass east of the area of the proposed action (Griffin, 1974). Both piping plovers and American oystercatchers nest within the Cape Cod National Seashore. Migrating birds could potentially pass through Nantucket Sound and the project area on their way to and from nesting grounds to the north.

#### 4.2.4.2.2 Wading Birds (herons, egrets, ibis, etc.)

These birds are numerous during migration and the summer months along the shorelines of bays and estuaries of Nantucket Sound. Small numbers may fly over the area of the proposed action, but are unlikely to linger at Horseshoe Shoal as the water depths are too deep for them to wade. None were observed during surveys conducted by the applicant or by MAS.

### 4.2.4.3 Marine Birds

This section describes the bird species that spend the majority of their time in Nantucket Sound away from shore and may be regular visitors to the area of the proposed action for purposes of feeding or resting. Roseate terns are a federally-endangered species and are discussed in more detail in Section 4.2.9 and the BA in Appendix G.

#### 4.2.4.3.1 Loons

Common loons (*Gavia immer*) and red-throated loons (*Gavia stellata*) are known to frequent the coastal waters of Massachusetts, particularly during migration and the winter months. The common loon is most often found in Nantucket Sound during spring and fall migrations with a few individuals remaining throughout the year. The common loon winters along the eastern seaboard after moving from inland lakes. The common loon is reported to be a diurnal migrant; migration routes follow coastlines and also pass overland (Williams, 1973; Viet and Petersen, 1993). The worldwide population has been estimated at 500,000 to 700,000 (Rose and Scott, 1996), the majority of which are found in Canada.

The red-throated loon breeds in tundra and far northern coastal regions. It is found wintering in coastal areas and is a common winter resident from southern Newfoundland to northern Georgia. Some subadults remain in wintering grounds all year and do not accompany adults to breeding grounds. In Massachusetts, spring migration peaks in April (Veit and Petersen, 1993). Fall migration into and through Massachusetts peaks in November (Kerlinger, 1998). There are currently no population estimates for red-throated loons in the Western Hemisphere though Canada is thought to have the second largest population after Russia's estimated 70,000. Swedish and Alaskan populations of red-throated loons experienced declines in the 1980s (SOF, 1990 *as cited in* Eriksson, 1994; Groves et al., 1996). It has been postulated that observed declines may have been an outcome, at least in part, of the acidification of some northern lakes (Pakarinen and Järvinen, 1984; Eriksson, 1994).

Because they are difficult to differentiate, particularly during aerial surveys, observations of both loon species were combined for this discussion. During the applicant's boat and aerial surveys a total of 8,229 loons were observed within the survey area of Nantucket Sound (see Table 4.2.4-5) with peak numbers observed during the aerial surveys on March 29 and April 5, 2002, (Report No. 4.2.4-4) and April 23, 2003, (Report No. 4.2.4-10). Thereafter, numbers observed dropped to nearly zero until November when their numbers increased considerably. In late December 2002 numbers observed dropped off once more and began to increase again in mid-February 2003 (Report No. 4.2.4-9). These changes reflect the timing of migrations by these species in the eastern United States and use of Nantucket Sound as a staging area during migration (Veit and Petersen, 1993). This trend continued through 2003 when observations of loons dropped off considerably in the summer months and increased again in November while migrating through the area in the fall of 2003 (Report Nos. 4.2.4-4, 4.2.4-8 and 4.2.4-10). It is evident from the surveys that more individuals migrate through the area in the spring than in the fall.

In winter, both species were detected throughout the study area (Report Nos. 4.2.4-4, 4.2.4-9, 4.2.4-10 and 4.2.4-11), and occurred singly or in small groups. In spring, flocks included as many as 100 individuals.

The MAS aerial surveys of Nantucket Sound documented very few loons in the Sound during August and September of 2002, 2003, and 2004 (see Table 4.2.4-6). The 34 surveys conducted in the premigratory staging period included 129 loon observations while six surveys during the 2003 and 2004 breeding periods included 62 loon observations in the Sound (Sadoti et al., 2005a, 2005b). Loon observations in the Sound were higher during the winter months. The 13 aerial surveys in the winter of 2003 to 2004 contained 3,756 loon observations (Perkins et al., 2004c). This represented less than 1 percent of all bird observations in Nantucket Sound during these surveys. Over 2,000 loons were observed on a single aerial survey in early April, indicating that spring migrants were moving through the Sound at this time. These trends of increased numbers in the early spring followed by greatly decreased numbers during summer and early fall were also observed during the applicant's surveys. During 41 boat surveys of Horseshoe Shoal in the Spring and Summer of 2003 and 2004, MAS observed 172 loons on the shoals, 11 of which were traveling above 40 ft (12.2 m) above mean sea level (AMSL). During boat surveys in Horseshoe Shoal 168 loons were recorded during the breeding period in 2003 and 2004 (Perkins et al., 2004a and Sadoti et al., 2005a).

#### 4.2.4.3.2 Grebes

Horned grebes (*Podiceps auritus*) and red-necked grebes (*Podiceps grisegena*) occur as winter residents within Nantucket Sound. Both species reliably appear in the Sound by October, but they rarely occur in large numbers. Grebes generally leave their wintering grounds by May. Because they are difficult to differentiate, particularly during aerial surveys, grebe observations were combined for this discussion.

Little was known about grebe use of the Sound prior to surveys of the study area in 2002 through 2005. Grebe observations made during surveys by the applicant and MAS are provided in Tables 4.2.4-7 and 4.2.4-8. Grebes were most often observed during the winter and spring months and peaked in March (Report No. 4.2.4-10) when 57 individuals were observed. They were not typically observed in summer or early fall (Report No. 4.2.4-10). The largest numbers of grebes were present in the study area during January, March, April, and December. Grebes were widely distributed across the study area in small numbers, but were more numerous in the southern section of the study area on Tuckernuck Shoals (Report No. 4.2.4-9 and Report No. 4.2.4-10). Grebes occurred singly or in small flocks on the water. As is typical of grebes, they were rarely observed flying. For example, of the 314 individuals observed during the aerial surveys, only one was seen flying; however, its flight altitude was within rotor height.

During their winter aerial surveys, MAS also observed few grebes (see Table 4.2.4-8). Winter boat surveys of Horseshoe Shoal in 2003 to 2004 documented a single horned grebe on the shoals (Perkins et al., 2004c). During 40 aerial and 39 boat surveys, MAS did not observe any grebes in Nantucket Sound in the breeding periods of 2003 and 2004 or premigratory periods of 2002, 2003, and 2004 (Sadoti et al., 2005a,b).

#### 4.2.4.3.3 Wilson's Storm-petrel

A summer visitor to the region (May through September), the Wilson's storm-petrel (*Oceanites oceanicus*) is generally abundant offshore (500 to 1,000 individuals per day per locality (Veit and Petersen, 1993). During aerial and boat surveys, the applicant did not find this species to be abundant (see Table 4.2.4-9). Observations tended to be located in the eastern third of Nantucket Sound (Report No. 4.2.4-3). Of the storm-petrels observed, all were spotted flying below 10 ft (3 m) AMSL. This species is not easily distinguished from Leach's storm-petrels (*Oceanodroma leucorhoa*), especially during aerial surveys. However, Leach's storm-petrels are not known to frequent Nantucket Sound but do occur in Buzzard Bay where there is a small nesting colony on Penikese Island (Veit and Petersen, 1993). For the purposes of this document, observed storm-petrels were assumed to be Wilson's storm-petrel.

The MAS aerial surveys (Perkins et al., 2003; 2004b; Sadoti et al., 2005b) observed 62 Wilson's storm-petrels in Nantucket sound during premigratory staging in 2002, 2003, and 2004 (see Table 4.2.4-10). A single individual was observed in 2002 on Horseshoe Shoal during a boat survey, and this storm-petrel was seen fishing over the shoal at a height of 2 ft (0.6 m) AMSL. During the breeding seasons of 2003 and 2004, 10 storm-petrels were seen during aerial surveys and 33 were seen during boat surveys (Perkins et al., 2004a; Sadoti et al., 2005a). The majority of these individuals, except for two seen fishing, were traveling across the Shoal at less than 15 ft (4.5 m) AMSL. As expected for a species that is a summer visitor, there were no Wilson's storm-petrels observed during the winter surveys.

### 4.2.4.3.4 Northern Gannet

Northern gannets (*Morus bassanus*) breed in three colonies in the Gulf of St. Lawrence and three colonies on the Atlantic coast of Newfoundland. The breeding population in 1999, obtained from counts of aerial photographs, was at 72,289 breeding pairs. Northern gannets winter all along the Atlantic and Gulf Coast, and large concentrations have been observed off the coast of Massachusetts (Veit and Petersen, 1993).

Northern gannets typically occur in Nantucket Sound from mid-March to early June and from mid-November to mid-January. The highest counts of northern gannets were observed in April and May (Report Nos. 4.2.4-4, 4.2.4-9 and 4.2.4-10). Northern gannets occurred singly and in flocks numbering up to 80 individuals throughout the study area. One large flock of approximately 300 individuals was observed just north of the study area in mid-April 2003 (Report No. 4.2.4-10). Some individuals were detected on the water, but the majority was observed flying. Of the flying individuals, 28 (1.9 percent) of the 1,415 individuals were seen flying at rotor height. Of the 1,415 total gannet observations during the aerial surveys, 1,081 (76.4 percent) were observed outside the three shoal areas (see Table 4.2.4-11). Northern gannets tended to be most often detected in the southern and eastern parts of the Sound (Report Nos. 4.2.4-4, 4.2.4-9, 4.2.4-10 and 4.2.4-11).

Similar to the observations of the applicant, MAS also observed the majority of northern gannets in the late fall or spring (see Table 4.2.4-12). In the winter of 2003 to 2004, 629 northern gannets were seen in the Sound during aerial surveys. In two boat surveys, one northern gannet was observed over Horseshoe Shoal (Perkins et al., 2004c). During three seasons of premigratory aerial surveys, 13 northern gannets were observed, all in 2002 surveys (22,883 total birds observed). Throughout the summer of 2003 and 2004, 179 northern gannets were observed during boat surveys of Horseshoe Shoal, none of which were seen flying in the rotor swept zone. A total of 29 northern gannets were observed during 2003 and 2004 summer aerial surveys (2,685 total birds over 2 summers) (Sadoti et al., 2005a).

### 4.2.4.3.5 Cormorants

Two cormorant species utilize Nantucket Sound, the double-crested cormorant (*Phalacrocorax auritus*) and the great cormorant (*Phalacrocorax carbo*). Great cormorants are primarily present within the area of the proposed action during winter, and double-crested cormorants are more abundant during summer months, although some winter presence is also common.

Double-crested cormorants winter and breed along the coast of Massachusetts (Hatch and Weseloh, 1999). Those that spend part of the winter in Massachusetts arrive in late March at the earliest. Peak autumn migration has been noted in the first half of October (Nisbet and Baird, 1959). Double-crested cormorants have typically been observed beginning migration flights soon after dawn and flying all day, though some flocks have been seen flying in the late evening with few stopping to roost for the night (Nisbet and Baird, 1959). Cormorants usually fly low over water in loose V-formations and follow the coastline but are known to fly overland to bypass Cape Ann and Cape Cod in Massachusetts. When flying overland, cormorants often fly up to 3,280 ft (1000 m) above ground. Populations are estimated at 350,000 breeding pairs in North America with 96,000 pairs breeding on the Atlantic Coast. Populations have been increasing significantly for about thirty years (Hatch and Weseloh, 1999).

Great cormorants winter along the Atlantic Coast and are seen intermingling with double-crested cormorants off the coast of Massachusetts. The North American population of great cormorants is relatively small. Hatch et al. (2000) estimated the northwest Atlantic population of great cormorants to be approximately 8,500 pairs; it was recently proposed that this number has since declined dramatically (Nisbet and Veit, in review).

The two cormorant species are not readily distinguishable; species counts were not differentiated in the field studies and are similarly combined in this account.

A total of 2,511 cormorants were observed within the study area during the aerial surveys (see Table 4.2.4-13). Most cormorant observations were within 3 miles (4.8 km) of shore. Of the total cormorant observations, 2,506 were observed outside the three shoal areas. Six individuals were observed on Horseshoe Shoal during boat-based observations. Cormorants were observed frequently in small groups or large dense flocks at daytime resting areas on Fernando's Fetch (a transient sandbar northwest of Muskeget Island), on Bishop & Clerks' Lighthouse near the northern edge of the Sound and along the shores of Muskeget Island. Those observed flying were typically low to the water's surface, yet one flock of 40 individuals was observed flying at rotor height. During aerial surveys conducted in September 2002 through February 2003, an average of 113.4 cormorants was seen in the project area (Report No. 4.2.4-9). Conversely, an average of 8.6 cormorants was seen in the project during the same aerial surveys conducted in September 2003 through February 2004 (Report No. 4.2.4-11). Outside the study area, cormorants were frequently observed close to shore and on the sandbars west of Monomoy, especially during post-breeding dispersal for double-crested cormorants in August (Report No. 4.2.4-9).

MAS observed very few cormorants during winter 2003 to 2004 surveys (see Table 4.2.4-14) suggesting migrants had left Nantucket Sound for more southern wintering grounds by early December. During boat surveys in the winter of 2003 to 2004, no cormorants were observed in Horseshoe Shoal, while only 7 were observed during aerial surveys. Cormorants were more often seen in the Sound during the breeding and premigratory staging period. Over two years of boat surveys during the breeding period, 28 cormorants were observed in Horseshoe Shoal and 16 were observed there during the three years of premigratory staging surveys. Aerial surveys of the Sound at these times show more activity than in the winter, though sightings averaged approximately 0.18 cormorants/ square mile (0.07 cormorants/km$^2$) (or 265 cormorants in 6 surveys) during the breeding period and <0.01 cormorants/square mile (<0.004 cormorants/km$^2$) (or 1,337 cormorants in 34 surveys) during the staging period (Sadoti et al., 2005b; Perkins et al., 2004b).

### 4.2.4.3.6 Seaducks

Five species of seaducks migrate in large numbers through Nantucket Sound and adjacent waters in the spring and fall, and many are winter residents. These seaducks are divers that feed principally on benthic mollusks and crustaceans, although some species readily feed on fish. In summer, when most individuals have left the area, small numbers of common eiders (*Somateria mollissima*) nest on Muskeget Island and also on the Elizabeth Islands outside of Nantucket Sound (Veit and Petersen, 1993). A brief discussion of each of the five species of seaducks observed is presented below.

**Common Eider**

Common eiders are known to both breed and winter along the Massachusetts coastline (Veit and Petersen, 1993). Fall migration brings thousands of eiders to Massachusetts in October and November (Veit and Petersen, 1993). Large rafts of eiders commonly assemble in locations where prey is available in high concentrations, particularly in shallow water (Guillemette et al., 1993). Migrants tend to follow the coastline when moving south (Reed, 1975). In spring, eiders migrate more quickly, sometimes taking shorter, overland routes. The total winter population of common eiders for North America is estimated to be 600,000–750,000 individuals (Goudie et al., 2000). Bourget et al. (1986) estimated that 181,000 common eiders winter from Maine to Massachusetts.

During aerial surveys conducted by the applicant, a total of 110,555 eiders were observed within the study area (see Table 4.2.4-15). Eiders accounted for approximately one-quarter of all birds observed in Nantucket Sound during winter surveys. From October to April, eiders were present in substantial numbers, often occurring in large, dense "rafts" numbering thousands of birds. These large rafts often extended beyond the edges of the study transects and therefore were not counted completely. Eider numbers were observed to decrease significantly during the aerial surveys conducted in February when large sections of the study area were frozen over (Report No. 4.2.4-9 and Report No. 4.2.4-11). During the summer, small numbers were observed near Muskeget Island, where a few pairs have nested each year since about 1973 to 1975 (Veit and Petersen, 1993).

Approximately 90 to 97 percent of all eiders detected during two winters of aerial surveys were observed outside the shoal areas (see Table 4.2.4-16). The average number of common eiders counted in Horseshoe Shoal was between 2 and 8 percent of the average number of all eiders counted. For Monomoy-Handkerchief and Tuckernuck Shoals, eider count averages were below 2 percent. Most observations of eider were in the southern part of the study area, between Tuckernuck Shoal and Martha's Vineyard, and in the northeastern part of the Sound near Monomoy Island (Report Nos. 4.2.4-3, 4.2.4-4, 4.2.4-9 and 4.2.4-11). Eiders were observed both on the water and flying; of the 110,555 individuals detected during aerial surveys, none were observed flying at rotor height.

During boat surveys conducted by the applicant, 279 eiders were observed in April 2002, 77 were observed in October 2002, 155 were observed in April 2003, and 1 was observed on August 27, 2003 (Report Nos. 4.2.4-3, 4.2.4-4, 4.2.4-9 and 4.2.4-11). Eider counts during boat surveys were considerably lower than those of aerial surveys, which were conducted at roughly the same time.

MAS observed one eider during two years of aerial surveys conducted during the breeding season and 86 eiders during boat surveys, most of which were observed on a single day in April 2004. All of these were traveling in smaller groups at a height of 4 ft (1.2 m) above the water. Of the waterbirds counted during each of 13 aerial surveys conducted during the 2003 to 2004 winter surveys, between 30 and 88 percent were Common Eiders (see Tables 4.2.4-15 and 4.2.4-16). The two highest counts for the season were 53,278 on January 22, 2004, and 40,551 on March 10, 2004. Of all the eider observed in the Sound in winter 2004, 8.3 percent were seen in Horseshoe Shoal and 90.3 percent were outside of the study area (Perkins et al., 2004c).

### Long-tailed Duck

Long-tailed ducks (*Clangula hyemalis*) winter on both coasts of North America and remain in the northern areas as long as waters remain open (Robertson and Savard, 2002). The ducks begin northward migrations in late-March or early-April and gather in large flocks in arctic waters until inland breeding grounds have opened (Veit and Petersen, 1993; Robertson and Savard, 2002). Fall migrants move south from molting grounds and numbers tend to peak in late-November and December (Veit and Petersen, 1993). The Atlantic coast wintering population has been difficult to estimate due to this species offshore foraging habits and light colored plumage, which make long-range observation difficult (Robertson and Savard, 2002).

Long-tailed ducks are understood to roost at night in Nantucket Sound and then fly in large flocks over Nantucket and Tuckernuck Islands to forage over the Nantucket Shoals during the day (Davis, 1997). These birds fly in flocks between daytime feeding areas on the shoals southeast of Nantucket and nocturnal roosts in the Sound (Davis, 1997). During a preliminary project survey flight in December 2001, a large roost was located in the southern part of the Sound, north of Tuckernuck. Several attempts were made during the aerial surveys to investigate this phenomenon but were unsuccessful, in part because the birds start moving before sunrise and continue after sunset. Long-tailed ducks were observed flying below 35 ft (10 m) AMSL during all observations made from plane or boat. They are known to fly at higher altitudes over or near land during foraging and roosting flights.

Aerial surveys conducted by the applicant are summarized in Table 4.2.4-17. Seasonal occurrence of long-tailed Ducks in Nantucket Sound was generally from October through April. No Long-tailed Ducks were recorded in summer. The largest numbers were counted during aerial surveys in March 2002 and November 2003, when migrants may use the Sound as a staging area. They were absent from May through September and were first observed in October each year. During the aerial surveys, 52,192 individuals were recorded. Of these, 4,103 (8 percent) were observed in Horseshoe Shoal, 2,685 (5 percent) were observed in Monomoy-Handkerchief Shoal, 2,493 (5 percent) were observed in Tuckernuck Shoal, and 42,911 (82 percent) were observed outside the three shoal areas. These ducks were more numerous in the northeastern corner and southern section of the Sound (Report Nos. 4.2.4-3, 4.2.4-4, 4.2.4-9 and 4.2.4-11).

MAS also documented long-tailed ducks only in the winter and spring (see Table 4.2.4-18). During MAS aerial surveys from December 2003 through April 2004, 33,379 long-tailed ducks were observed, representing about 8.1 percent of all birds counted during this survey period. The largest numbers were seen in December and January, though thousands of ducks were still documented in early April. Long-tailed ducks were found to be more evenly distributed throughout the Sound than common eider or the long-tailed duck observations recorded by the applicant. MAS observations of 1,209 long-tailed ducks during two boat surveys in the winter of 2003 to 2004 constituted about 31 percent of all birds counted (Perkins et al., 2004c).

In order to better understand long-tailed duck flights in and out of the Sound and find nighttime roosting locals, a study was conducted from December 2005 through March 2006 (Report No. 4.2.4-12). Land-based observations combined with boat surveys and airplane reconnaissance were used to observe duck movements in Nantucket Sound and Horseshoe Shoal. Land-based surveys were conducted from the western end of Nantucket Island at sunrise and sunset in order to record the flight paths and heights of birds leaving and returning to roosting areas. Land surveys were performed in varying weather conditions though at times this meant reduced observation of commuting ducks. Boat-based crews made observations from within the Sound in order to track duck flights and roosting behavior in the area of the proposed action. The study attempted to obtain information on flight paths, flight altitudes, and roosting locales of commuting ducks.

During morning surveys (Report No. 4.2.4-12), long-tailed ducks were seen flying due south through Tuckernuck Channel, coming from the northeast and turning as they passed Eel Point. The majority of ducks observed (67 percent) followed this flight path. Others flew southeast and southwest as they passed Eel Point. Roosting areas in Nantucket Sound could not be determined for long-tailed ducks, so the origination of these flights is unknown; however ducks were observed moving to the northeastern part of the sound during boat and land surveys. One morning in December during this study, nearly one hundred thousand long-tailed ducks were counted making this commute from their nighttime roosting area to their daytime feeding area. These kinds of numbers are not unusual in Nantucket Sound in winter (Davis, 1997). A winter nocturnal duck study conducted for two nights in March 2005 did not find evidence of large gatherings or flights of long-tailed ducks moving into Nantucket Sound in the late evening (Report No. 4.2.4-13). However, hundreds were seen in the southeastern part of the Sound in an area outside of the usual aerial survey transects (Report No. 4.2.4-13).

During the evening surveys 99 percent of all ducks were observed moving north or northeast as they passed Eel Point and as they returned to the Sound. During flights between roosting and foraging areas the ducks were observed flying at lower altitudes when flying into a headwind, 66 percent flying less than 25 ft (7.6 m) above the water, 34 percent flying between 25 and 150 ft (7.6 and 45.7 m). Conversely, ducks were seen flying at higher elevations when flying with a tailwind. Under these conditions the majority (84 percent) were seen flying between 25 and 150 ft (7.6 and 45.7 m) AMSL, and 15 percent flying higher than 150 ft (45.7 m). During evening flights it was noted that ducks increased their flight altitude as they passed over land, and then quickly returned to lower elevations once over water again. This behavior was observed except when ducks were flying into a strong headwind, in which case they flew very low (within 10 ft [3 m]) over land (Report No. 4.2.4-12).

A satellite telemetry study investigated the movements of six long-tailed ducks in Nantucket Sound and Nantucket Shoals from December 2007 to April 2008 (Allison et al., 2008). The study attempted to determine night-time roosting locales for long-tailed ducks. More than 650 satellite fixes of the six ducks gave no evidence that commuting long-tailed ducks used Horseshoe Shoal for night-time roosting.

Black scoters (*Melanitta nigra*), white-winged scoters (*Melanitta fusca*) and surf scoters (*Melanitta perspicillata*) are all known to migrate through or winter off the coast of Massachusetts (Veit and Petersen, 1993). All three species of scoters were present in Nantucket Sound in large numbers through the winter, and migrants are known to pass through the area. Together the scoters comprised the largest group of birds observed during the study year, representing 51.6 percent of the total count.

A total of 212,872 scoters were observed by the applicant during the study period (205,802 during aerial surveys and 7,070 during boat surveys). The three species were combined in the reports because the sightings could frequently not be identified to species, especially when conditions for observation were less than ideal or when the scoters were in mixed flocks. Peak numbers were observed from October through April, with the numbers starting to decline in mid-April (see Table 4.2.4-19). The largest numbers of scoters were observed during the November 2003 aerial surveys when individuals were arriving for the winter and migrating through from their breeding colonies (Report No. 4.2.4-3, additional data in Report No. 4.2.4-11). Scoters occurred in small groups and loose flocks numbering up to thousands of individuals, and were widely distributed in the Sound. Of the 205,802 observed during the aerial surveys, 15,222 (7.4 percent) were observed in Horseshoe Shoal, 18,678 (9.1 percent) were observed in Monomoy-Handkerchief Shoal, 30,419 (14.8 percent) were observed in Tuckernuck Shoal, and 141,483 (68.7 percent) were observed outside the three shoal areas. Only 13 scoters were observed during the summer months in all of Nantucket Sound. Flying scoters were generally observed at altitudes less than 15 ft (4.6 m) AMSL, with the exception of flocks of possible migrants at about 65 ft (20 m) AMSL. Large numbers of scoters were observed southwest of Martha’s Vineyard in flocks numbering up to 3,000 individuals on March 24, 2003. Of the 212,872 scoters observed during the aerial and boat surveys, four individuals were documented flying within the height of the rotors (Report No. 4.2.4-10).

MAS also observed a preponderance of scoters during winter surveys (see Table 4.2.4-20). A total of 94,631 were seen during the study period, 91,244 of which were observed from December 2003 to April 2004. The largest number of scoters was seen during an aerial survey on January 22, 2003, when 25,727 individuals were observed in the Sound. During the winter period, 56.3 percent of scoters observed in the Sound were outside of all three alternative sites. On average, 15.8 percent were seen in Horseshoe Shoal over the course of the 2003 to 2004 winter surveys. During two boat surveys of Horseshoe Shoal in this same winter, 1,750 scoters were observed on the shoals. During MAS surveys, scoters made up 22 percent of all bird observations in the Sound and were the second most abundant group of birds after the common eider in the winter of 2003 to 2004 (Perkins et al., 2004c).

**Red-breasted Mergansers**

The red-breasted merganser (*Mergus serrator*) is present as a wintering bird along the Massachusetts coast. These mergansers are known to migrate into the area in late October and November and stay until early May. Generally this bird is not known to migrate or winter in mixed flocks with other species.

Flights overland from inland breeding grounds may occur at night, though red-breasted mergansers are generally known to migrate along coastlines during the day in small flocks of 5 to 15 (Titman, 1999).

A total of 1,452 red-breasted mergansers were observed within the study area during field investigations by the applicant (Report Nos. 4.2.4-3, 4.2.4-4 and 4.2.4-9). Red-breasted mergansers were observed from October through April and they were not observed from late April through September during both study years (Table 4.2.4-21). Of the 1,218 observations during the aerial surveys that distinguished between alternative sites, 117 (9 percent) were observed in Horseshoe Shoal, 0 (0 percent) were observed in Monomoy-Handkerchief Shoal, 0 (0 percent) were observed in Tuckernuck Shoal, and 1,101 (90 percent) were observed outside the three shoal areas. Of the 117 observed within Horseshoe Shoal, 107 were seen on November 24, 2003. They generally occurred close to shore, near Muskeget and Tuckernuck Islands. None were observed flying at rotor height.

MAS observed 56 red-breasted mergansers during the winter 2003 to 2004 surveys (see Table 4.2.4-22). One merganser was observed in the Sound during an aerial survey in late September 2003 (Perkins et al., 2004b). The largest number of mergansers seen in a single survey by MAS was 32 individuals in December, 2003 (Perkins et al., 2003).

**Goldeneyes**

The common goldeneye (*Bucephala clangula*) and Barrow's goldeneye (*Bucephala islandica*) are known to be present in Nantucket Sound in the winter or as winter migrants but are generally low in numbers. The applicant observed eight goldeneyes, in similar coastal locations as the red-breasted merganser observations. Of the eight observed, six were observed during the aerial surveys, all of which were observed outside of the three alternative sites. None were observed flying at rotor height. MAS did not observe any goldeneyes during surveys (Perkins et al., 2004a,b,c; Sadoti et al., 2005a,b).

### 4.2.4.3.7 Gulls

Six species of gulls were observed during the surveys. Gulls are abundant as year-round residents and migrants that travel over large areas of the Sound in search of food, often targeting schools of fish or working fishing boats. Approximately 65,000 nest in Massachusetts (Blodget and Livingston, 1996). A total of 6,229 individuals were observed during the boat and aerial surveys conducted by the applicant with 5,500 being observed during the aerial surveys (see Table 4.2.4-23). Gulls were observed during all aerial surveys during the study years. Of these, the great black-backed gull (*Larus marinus*) was the most abundant (2,220), followed by the herring gull (*Larus argentatus*) (1,605), Bonaparte's gull (*Larus philadelphia*) (1,444), black-legged kittiwake (*Rissa tridactyla*) (319), laughing gull (*Larus atricilla*) (150), and ring-billed gull (*Larus delawarensis*) (2). In addition, a total of 414 other individual gulls recorded during the surveys were not identified to species.

Gulls were sparsely and relatively evenly spaced throughout Nantucket Sound (Report Nos. 4.2.4-4, 4.2.4-8, 4.2.4-9, 4.2.4-10 and 4.2.4-11). Of the 5,500 individuals observed during the aerial surveys, 227 (5.0 percent) were observed in Horseshoe Shoal, 132 (2.4 percent) were observed in Monomoy-Handkerchief Shoal, 552 (10.0 percent) were observed in Tuckernuck Shoal, and 4,539 (82.5 percent) were observed outside the three shoal areas. They were most common in November and December during both study years, primarily due to the presence of Bonaparte's gulls within the study area during that time of year. Many gulls were observed on the water and flying, with a total of 85 of the 5,500 individuals observed during aerial surveys (mostly herring and black-backed gulls) seen in flight at rotor height. Four parasitic jaegers (*Stercorarius parasiticus*) were observed foraging off Monomoy Island on the September 12, 2003, boat surveys.

A total of 8,030 gulls of six species were observed in the Sound during MAS aerial surveys. In these aerial surveys the herring gull (1,610) was most abundant, followed by the greater black-backed gull (1,902), the black-legged kittiwake (578), Bonaparte's gull (61), and the laughing gull (59). A large number (3,820) of unidentified gulls were also seen throughout the aerial surveys. These same gulls were commonly seen during boat surveys of Horseshoe Shoal as well. Greater black-backed gulls (513), herring gulls (193), undifferentiated gulls (77), laughing gulls (7), black-legged kittiwakes (6), and Bonaparte's gulls (6) were all counted on the shoals in all seasons of survey. In addition, a single jaeger (*Stercorarius* spp.) was seen traveling at 4 ft (1.2 m) AMSL over Horseshoe Shoal during the breeding period of 2004 and eight jaegers (*Stercorarius* spp.) were seen traveling in the Sound on aerial surveys from September 2002 to September 2004 (Sadoti et al., 2005a; Sadoti et al., 2005b; Perkins and Allison, 2003; Perkins et al., 2004b).

#### 4.2.4.3.8 Terns

Common (*Sterna hirundo*), roseate (*Sterna dougallii*), arctic (*Sterna paradisaea*), and least (*Sternula antillarum*) terns can all be found nesting along the shoreline of Nantucket Sound. These birds are summer residents, almost 20,000 pairs of the four species nest in Massachusetts, the majority in the southeastern part of the state (Blodget, 2001 *as cited in* Perkins et al., 2003). Roseate terns are a federally-endangered species and are discussed in more detail in Section 4.2.9 and the BA in Appendix G; the other three tern species are of Special Concern in Massachusetts. In 2005, there were 15,447 pairs of common tern at 34 sites in Massachusetts, 90 percent of which were concentrated at the Monomoy National Wildlife Refuge, Chatham, and Bird and Ram Islands (Mostello, 2007). As of 2002, least terns bred at 54 locations in Massachusetts; there were 3,420 breeding pairs in the state in 2001 (Mostello, 2002). Breeding common and least terns are considered to be locally abundant in Nantucket Sound. However, there are concerns about populations of these two species in other geographic locations, and many terns do migrate through Nantucket Sound from other breeding populations that may be more at risk.

Terns are typically present in the Sound from early April until late September at breeding colonies and staging areas. The extent to which terns use Nantucket Sound is not fully understood. However, fewer terns were observed on Horseshoe Shoal during surveys conducted by the Applicant and MAS during the breeding season.

The applicant and MAS conducted aerial and boat surveys from June 2001 through September 2004 to determine tern distribution and abundance in Nantucket Sound and the area of the proposed action, as well as to document tern behavior within the area of the proposed action. These surveys were timed to capture spring migrant, breeding population and pre-migratory staging use of the Sound. Five species of tern were observed during these surveys with common, roseate and least terns being the most abundant (Perkins et al., 2004a,b; Sadoti et al., 2005a,b; Report Nos. 4.2.4-3, 4.2.4-8, 4.2.4-9, 4.2.4-10 and 4.2.4-11). Small numbers of black and Forster's terns were also observed, typically in mixed flocks with common and roseate terns (Report No. 4.2.4-4).

The earliest tern sightings in Nantucket Sound occurred in April. Nineteen common terns were seen in April, 2002, (Report No. 4.2.4-4) and two common terns were seen on April, 2003, (Report No. 4.2.4-10). These individuals appeared to be spring migrants, newly returned to the Sound (Perkins et al., 2003a). The largest numbers of terns were observed in mid-May before nest initiation of terns breeding within the Sound and likely included migrants traveling through the Sound on their way to more northern and eastern breeding colonies (Perkins et al., 2004a; Sadoti et al., 2005a).

A total of 8,755 terns were observed within the study area from April to September in 2002 and from April to November in 2003 (Report Nos. 4.2.4-3, 4.2.4-4, 4.2.4-8, 4.2.4-9, 4.2.4-10 and 4.2.4-11).

Common terns were the most abundant (5,313), followed by roseate terns (447), and least terns (198), black terns (40), and Forster's terns (2). However, 2,755 individual terns could not be identified to species, because roseate and common terns are similar in appearance and often occur in mixed flocks. A few black terns and Forster's terns were observed during the summer of 2003. Observations outside the study area suggest that terns were more numerous along the shore than in the study area, which is influenced by the proximity of a concentrated prey base that occurs in shallower waters.

During all of the aerial surveys, a total of 2,888 individuals were observed within the study area, of which 277 (9.6 percent) terns were observed in Horseshoe Shoal, 76 (2.6 percent) were observed in Monomoy-Handkerchief Shoal, 164 (5.7 percent) were observed in Tuckernuck Shoal, and 2,371 (82.1 percent) were observed outside the three shoal areas. During the aerial surveys, the number of flying terns recorded in each observation ranged from 1 to 201. Larger aggregations were infrequently encountered at roosting sites such as Fernando's Fetch (a transient exposed sandbar, present northwest of Muskeget Island during the surveys).

MAS (observed a total of 18,257 terns in the Sound from August 2002 to September 2004 (Perkins et al. 2003, 2004a,b,c, Sadoti et al., 2005a, 2005b). Common terns were more abundant (4,779) than roseate terns (832) though the majority of terns observed (12,646) were identified only as common/roseate type.

#### 4.2.4.3.9 Auks (alcids)

A total of 3,530 large alcids were observed in the study area during the study period (see Table 4.2.4-24). These were much more likely to be razorbills (*Alca torda*) than murres, puffins, or guillemots (Veit and Petersen, 1993), but specific identification was not established for most individuals. Alcids were seen throughout the study area from November to April, with an unusual, unconfirmed individual in June, 2002. Alcids occurred singly or in groups numbering up to 35 individuals and were relatively evenly distributed throughout the study area (Report Nos. 4.2.4-4, 4.2.4-9, 4.2.4-10 and 4.2.4-11). Aerial surveys conducted by the applicant documented a total of 3,455 individuals within the study area, of which 426 (12.3 percent) were observed in Horseshoe Shoal, 290 (8.4 percent) were observed in Monomoy-Handkerchief Shoal, 408 (11.8 percent) were observed in Tuckernuck Shoal, and 2,331 (67.5 percent) were observed outside the three shoal areas. Other observations of alcids included a total of 50 dovekies, recorded from January to May and one Atlantic puffin observed in March, generally in association with razorbills. All alcids seen flying were observed below approximately 50 ft (15 m) AMSL. MAS surveys observed 2,576 razorbills and 4 unidentified alcids during aerial surveys from fall 2003 to spring 2004 (Perkins et al., 2004c). Of these, 19 razorbills and one dovekie were observed in Horseshoe Shoal (Perkins et al., 2004c).

### *4.2.4.4 Additional Waterbirds Observed*

The following waterbirds were additional species/species groups that were observed in the study area during the study years but do not necessarily represent abundant species (Report No. 4.2.4-8 and Report No. 4.2.4-9).

#### 4.2.4.4.1 Sooty Shearwater

This visitor from the southern hemisphere is seen regularly in Massachusetts coastal waters in the summer, and was recorded in Nantucket Sound on 6 dates during May, June, August, and October. Ten individuals were observed within the study area during the study period, which involved periodic studies over more than two years. All were seen flying below approximately 25 ft (7.5 m) AMSL. Only one was observed during the aerial surveys.

#### 4.2.4.4.2 Other Ducks

A total of 14 greater scaup (*Aythya marila*) were observed in the southern section of the study area during an aerial survey in June, 2003. None were flying at rotor height. Also, a total of 109 American black ducks (*Anas rubripes*) were observed on Muskeget Island on four aerial surveys in the fall of 2003.

#### 4.2.4.4.3 Geese and Non-Seaducks

Large numbers of geese and non-seaducks pass close to shore during migration. The few that were observed during field studies included small numbers of Canada geese (*Branta canadensis*) that may have been residents. The Canada geese were observed at Muskeget Island and flying over Tuckernuck Island. In addition, a flock of 25 was observed flying through the study area in December, 2002, and 10 were observed in June, 2003. During boat surveys in September 2002, small numbers of high-flying snow geese (*Chen caerulescens*) were observed from the bluff at Cape Poge. Of the 35 geese observed during the aerial surveys, none were flying at rotor height. In addition, seven brants (*Branta bernicla*) were observed on the eastern part of the study area in February, 2004.

## 4.2.5 Subtidal Offshore Resources

### *4.2.5.1 Introduction*

A description of existing hard and soft-bottom benthic habitats and species, shellfish, meiofauna and plankton resources in the area of the proposed action is presented in this section. Information presented was derived from a review of the scientific literature, performance of site assessments, review of existing site assessment data, and agency consultation. As part of a characterization of shellfish resources in Nantucket Sound commercial shellfish resource information for the Sound from NMFS and MDMF data, including information on commercial shellfish species such as soft shell clams, surf clams, quahogs, bay scallops, mussels and conch whelk were evaluated. Further information on commercial and recreational shellfishing was obtained during a Survey of Commercial and Recreational Fishing Activities which involved interviewing shellfish and coastal officers. Shellfish resource information for the nearshore area of the proposed action including the landfall locale was obtained through communication with MDMF and Town shellfish constables. The information gathered during this research is presented here and used to determine the potential impacts of the proposed action in Section 5.3.2.5.

Macrobenthic organisms are those organisms that live on or beneath the seafloor. Macrobenthos includes organisms, such as polychaete and oligochaete worms, clams, snails, crustaceans, seastars, brittle stars, sand dollars, and other large invertebrates. As opposed to these larger benthic invertebrates, small benthic invertebrates, often referred to as meiofauna, are discussed in Section 4.2.5.5.1. For the purposes of this analysis, meiofauna are considered to be small benthic invertebrate animals ranging in size from 0.02 to 0.002 in (0.5 mm to 0.045 mm). Macrofauna are larger benthic invertebrate organisms (i.e., greater than 0.02 in (0.5 mm) in length). The evaluation of benthic resources has been in accordance with specific requirements that were established for this proposed action as part of the MEPA scoping process and then modified in the USACE EIS Scope of Work. As a result of agency communication with the USEPA (Colarusso, 2002) and the USACE (2002a, 2002b) a sampling design, protocol, and methodology were designed and implemented by the applicant. The benthic database for the project was updated during November 2005 following these same approaches in order to obtain additional benthic community information in areas of the proposed action that were not previously investigated due to a revised proposed action layout.

### 4.2.5.2 Hard Bottom Benthic Communities

Hard bottom areas with scattered boulders, cobble, and gravel have been confirmed by conducting side-scan sonar surveys of the project areas as well as more focused underwater video surveillance. Areas with this type of substrate are shown in Figure 4.2.2-1, Benthic Habitat Map. The side-scan sonar returns collected during three geophysical surveys were interpreted to represent scattered boulders (1 to 10 ft [0.3 to 3.0 m] in diameter) on the seafloor over approximately 10 percent of the area of the proposed action on Horseshoe Shoal with the remaining 90 percent of the shoal area relatively free of hard bottom substrate or boulders. The strong sonar returns indicative of glacially-deposited erratics are located primarily northwest of the ESP and along the western border of the array, though intermittent cobbles to boulders may be found scattered across the entire area of the proposed action. Along the submarine transmission cable route to the landfall in Yarmouth, the side-scan sonar results indicate rocky seafloor and boulders within an approximate 250 linear foot (76 m) length of the cable corridor south of Point Gammon and the entrance to Hyannis Harbor. This area corresponds to a zone of glacial drift paralleling and just offshore the present south coast of Cape Cod. The drift may be remnants of relict ice contact deposits left by an ice front temporarily stalled at this location during glacial retreat. The remaining seafloor along the submarine transmission cable route is interpreted as primarily unconsolidated sand-sized sediments.

Field sampling programs conducted in the areas of cobble as part of the Submerged Aquatic Vegetation Investigation (Report No. 4.2.2-1) indicated this type of habitat has macroalgae and attached invertebrates such as sponges. Although not observed or collected as part of the Submerged Aquatic Vegetation Investigation, other invertebrates that could be expected to occur include barnacles, mollusks and tunicates and various species of mobile invertebrates such as crabs, seastars, gastropods, and fish such as tautog.

### 4.2.5.3 Soft-Bottom Benthic Communities

From a review of the scientific literature, sand is a dominant bottom substrate in the area of the proposed action with mud and other fine-grained sediments occurring to a lesser extent. SAV, boulders and cobbles are not common. However, these types of substrates were reported to occur occasionally throughout the proposed action locale. Earlier studies of the area present information that focuses on the benthic community that is associated with the sandy substrate when describing and quantifying benthic resources of this area. Bottom sediment mapping for the area of the proposed action is provided in Figure 4.2.2-1, Benthic Habitat Map, and in Report No. 4.2.5-1.

Field studies performed within the area of the proposed action during the summer of 2001 and the spring of 2002 were designed to provide a general characterization of the benthic community in habitats present that include fine-grained sand, coarse-grained sand, presence or absence of sand waves, and differing depths. In no manner was the intent to provide quantitative species or population numbers for everywhere the project might disturb the seafloor. This approach is consistent with general scientific principles of subsampling in order to provide an understanding of a much bigger area. These field studies were performed during seasonal periods generally reported to have the greatest biological diversity and highest abundance of macroinvertebrates. For the purpose of biomonitoring or community characterization, late spring to early summer benthic sampling in North Atlantic coastal waters is widely supported in the literature (Rudnick et al., 1985; Heck, 1987; Holland et al., 1987; Sardá et al., 1995; Alden et al., 1997; NOAA National Centers for Coastal Ocean Science, 2006). Furthermore, single- or double-season sampling is just as effective as multi-season sampling, especially when conducted during the spring and/or summer (Alden et al., 1997). One reason for this is that benthic abundance and productivity in these waters are typically highest during the spring and early summer (Rudnick et al., 1985; Heck, 1987; Holland et al., 1987; Sardá et al., 1995). While this is most notable in intertidal and estuarine habitats (due to greater seasonal variation in environmental variables), it is also observable in subtidal marine waters (Whitlatch, 1977). In general, increased energy inputs during the spring translate into high abundance and diversity in coastal waters. Recruitment of most marine benthic taxa in the temperate zone crests during the spring (Alden et al., 1997; Chainho et al., 2006). The increase in energy availability that typifies environmental conditions at this time provides sufficient resources for the annual recruitment of a wide range of taxa. In Narragansett Bay, Rudnick et al. (1985) attribute the spring-early summer peak specifically to a combination of warming temperatures and the increased availability of diatomaceous detritus – a major food source for many benthic meio- and macrofaunal taxa – which reaches maximum availability in the spring and is typically exhausted by late summer. Recruitment success during this spring-early summer period is therefore critical to the maintenance of patterns in community structure over time across the region.

With a focus on dominant habitats during the period of peak abundance, this characterization of the soft-bottom benthic community describes existing conditions that are likely to approximate the maximum regarding the soft-bottom benthic community's diversity and abundance for the area of the proposed action.

#### 4.2.5.3.1 Review of Scientific Literature

Benthic fauna data that are available for Nantucket Shoals were obtained and reviewed by Battelle (2001). Based on a review of scientific literature, Nantucket Sound has been generally reported to be a highly productive area for benthic invertebrates. Numbers of benthic organisms typically average in excess of 186 organisms/square foot (2,000 organisms/m²) (Theroux and Wigley, 1998). The average faunal density throughout the entire area of the proposed action studied in 2001 was 388 organisms/square ft (4,180 organisms/m²) and 704 organisms/square ft (7,574 organisms/m²) across three shoals studied in Nantucket Sound in 2002. The average faunal density for four sites sampled in 2005 at new turbine locations was 1007 organisms/square ft (11,589 organisms/m²). It is likely that the abundance averages recorded during these studies are higher due to data collection in spring and summer which are typically periods of peak abundance. Also, the 2005 samples were collected in the fall when the community is dominated by a larger number of smaller organisms (Sanders, 1956). It is also a possibility that the higher numbers of organisms found in the recent studies may be due to differences in gear used. Historically, mesh size used for sieving samples may have been larger than the 500µm-mesh size used in the recent studies that may have resulted in retention of more organisms on the sieve. Benthic faunal diversity (i.e., numbers of species and numbers of individuals per species) in Nantucket Sound has been reported to be lower than diversity in the rest of the Southern New England Shelf (Theroux and Wigley, 1998).

As described in Section 4.1 and Report No. 4.2.5-1 Nantucket Sound has a sandy substrate that is mobile and dynamic as shown by the sand waves and ripple marks. Frequency and magnitude of the sand movements greatly influences the structure and abundance of benthic communities. The organisms that live in or on such sandy sediments are well adapted for settlement or movement in sand and also for recovery from natural burial.

A review of the literature shows that the most abundant taxa (in this document the term taxa is defined as either a distinct species or a group of similar species based on level of taxonomic identification used) in Nantucket Sound benthic fauna include crustaceans and mollusks followed by polychaete worms (Avery et al., 1996). Of the crustaceans, amphipods are noted to be most abundant. The sandy sediments in Nantucket Sound are reported as supporting a diverse assemblage of species of amphipods. The field studies and assessments performed for the proposed action during 2001 and 2002 support these conclusions (Report No. 4.2.5-1 and Report No. 4.2.5-2). Samples that were collected from offshore waters during 2002 were, however, dominated by large Nematoda (roundworms) that made up (by number) 45 percent of macroinvertebrate communities that were sampled from Horseshoe Shoal (see Table 4.2.5-1).

The literature reviewed indicated bivalves to be the most important and diverse of mollusks with gastropods also noted as commonly occurring (Pratt, 1973). MDMF (2001) indicated there is reported to be a heavily populated area of northern quahog (*Mercenaria mercenaria*) in shoals that are east of Horseshoe Shoal. Shellfish suitability areas for quahog in the area of the proposed action are shown in Figure 4.2.2-1, Benthic Habitat Map. It has been reported that bay scallops (*Argopecten irradians*) occur in shallow waters of Nantucket Sound especially near seagrass beds. Shellfish suitability areas for bay scallops in the area of the proposed action are shown in Figure 4.2.2-1, Benthic Habitat Map. It has also been reported that species of large gastropod whelks (*Busycon carica* and *Busycotypus canaliculatum*) are abundant in Nantucket Sound coastal waters (Davis and Sisson, 1988). The 2001 field study program was not specifically designed for capturing large size commercial shellfish. However, the 2002 field study program was modified through the use of a Van Veen grab sampler so that some larger organisms occurring deeper in the sediment would be accounted for in the analyses. While the addition of the Van Veen grab sampler, improves capture of larger benthic infauna and epifauna, it does not measurably improve the effectiveness of capturing species such as large gastropod whelks sea cucumbers, sea stars, or quahogs as these types of grabs are not always effective in capturing the adults of these species groups. A shellfish survey was conducted in 2003 in Lewis Bay to locate larger mollusks in the Project's landfall locale (Report No. 4.2.5-3). Documentation of northern quahogs in near shore areas was associated with Town of Yarmouth shellfish beds.

### 4.2.5.3.2 Project Field Surveys

The applicant conducted comprehensive benthic field sampling programs, in addition to the literature review of benthic conditions in Nantucket Sound and agency consultations. Five separate field surveys were performed in the area of the proposed action from 2001 through 2005. Ninety benthic samples were collected and analyzed. The field surveys in the area of the proposed action are summarized here. Data collection efforts performed are not as robust as needed for statistical analyses that provide a truly valid scientific quantitative characterization of benthic habitats over such a large area and variable conditions, however they still provide insight into the nature and general characteristics of the benthic communities present in the proposed action area, and to allow for a characterization of potential affects.

**2001 Benthic Macroinvertebrate Field Sampling Program**

During August 2001, an assessment of benthic organisms was performed along the proposed and alternative submarine transmission cable routes connecting Horseshoe Shoal to Lewis Bay and Popponesset Bay, respectively, along with an assessment of benthic organisms associated with the site of the proposed action (Report No. 4.2.5-2). The survey was conducted in order to characterize the composition of the benthic community of the proposed action area. One benthic sample was collected by surface grab methods at each of 46 locations, consistent with the proposed action's sediment core sampling program (see Figure 4.2.5-1). The sampling locations were selected to reflect the range of benthic habitats (Gibson et al., 2000) that occur along the proposed and alternative cable routes that originate from Lewis Bay and Popponesset Bay and from within the site of the proposed action on Horseshoe Shoal. Benthic macroinvertebrates from each sample were separated from sediment and debris, were identified to the lowest practical taxonomic level, and were counted.

The following information is a summary of the detailed results of the 2001 sampling Program found in Report No. 4.2.5-2. Amphipoda was the most abundant and diverse taxonomic class found. Amphipods dominated seven of the 46 grab sites in Nantucket Sound, with a maximum of 95 percent (by number) occurring at one site (BG-G7) that was located approximately 1.5 miles (2.4 km) north of Halfmoon Shoal. Two amphipod taxa reaching greatest abundance (> 1208/square ft [13,000/$m^2$]) include the Ampeliscidae and Ischyroceridae families. When amphipods were found in these high densities the samples had been collected in areas on or in the immediate Horseshoe Shoal locale. These findings are consistent with the data reported in the literature (Sanders, 1958; Avery et al., 1996) that noted very high densities of amphipods in the sandy bottom substrates that were sampled in shallow waters in Nantucket Sound.

Sampling also revealed a wide variety of gastropods in the proposed action locale. Relatively high densities of gastropods were often found including areas along the proposed submarine transmission cable route. The species composition documented during this study was basically consistent with the data that was reported in earlier studies of Nantucket Sound, Georges Bank, and the Southern New England Shelf (Wigley, 1968; Pratt, 1973; Theroux and Wigley, 1998).

**Results of the 2001 Benthic Sampling Program Outside Massachusetts Waters**

Data from samples collected during the 2001 benthic sampling program that were collected from Horseshoe Shoal and from the sections of the two alternative interconnecting routes located outside of the 3.5 mile (5.6 km) limit describe the composition of the benthic community outside the 3.5 mile (5.6 km) limit. The data indicate that Amphipoda dominate the benthic community in this locale. Ampelisidae and Ischyroceridae comprised greater than 68 percent of the macroinvertebrate community by number in this locale in 2001. Other common taxa that were reported from this area included convex slippersnail *(Crepidula convexa),* common Atlantic slippersnail (*Crepidula fornicate),* Bloodworm *(Glycera dibranchiate)* and Nematoda and comprised 18 percent of the macroinvertebrate community by number. These six taxonomic groups comprised 86 percent of the organisms by number in the locale in the 2001 study. There were 65 benthic taxa reported as occurring outside the 3.5 mile (5.6 km) limit and in the area of the proposed action at Horseshoe Shoal. Average numbers of taxa per sample in this locale in 2001 were 9.2 taxa/sample. The average number of organisms/square ft (organisms/m²) in this locale in 2001 was reported to be 521 (5,611).

**Results of the 2001 Benthic Sampling Program inside Massachusetts Waters**

During the 2001 sampling program 46 samples were collected in the area of the proposed action. Of these samples three were collected in Lewis Bay and five were collected along the route, within the 3.5 mile (5.6 km) limit of the area of the proposed action that connects Horseshoe Shoal with Lewis Bay. During this study the benthic community in this locale was dominated by the gastropod species (*Crepidula convexa* and *Crepidula fornicata)*. Slipper snails were documented in seven of the 46 samples collected in 2001. When found they occurred in very high densities (>743/square ft [8,000/m²]). Patchiness in the slippersnail distribution may be due to their dependence on stones and boulders which are scattered within the mainly sandy material. Slippersnails disperse via planktonic larvae (Collin, 2001) and can form accumulations of free-standing clusters on the seafloor if the larvae settle and then metamorphose on a stone. Additional larvae can then settle on the pioneer slippersnail and when that slippersnail dies and the attachment to the substrate is released the cluster can then become free-standing (Rayment, 2001). *Crepidula fornicata* is commonly reported attached to stones and shells in soft substrates or in muddy/mixed muddy areas (Rayment, 2001). *Crepidula fornicata* has been reported to alter sediment characteristics by removal of a large volume of suspended organic material from the water column and depositing that filtered material on the bottom as pseudofeces (GISD, 2008; MarLin, 2008). *Crepidula fornicata* is a suspension feeder and its diet has been noted to be composed mainly of pelagic algae of various sizes and forms, but also benthic ones, and detritic and bacterial material (GISD, 2008). JNCC (2008) notes that *Crepidula fornicata* competes with other filter-feeding invertebrates for space and food. Effects of *Crepidula fornicata* on benthic communities differ depending on the habitat they colonize: in muddy sediments, presence of *Crepidula fornicata* apparently stimulates the zoobenthic community diversity and abundance (mainly deposit-feeders); in coarser sediments, macrofauna community is different (more suspension-feeders) from the community that is associated with *Crepidula fornicata* (de Montaudouin and Sauriau, 1999). Additional taxa that were common from samples in this locale included Phoxocephalidae (hood-headed amphipods), *Lumbrineris* sp., Nematoda (roundworms), and Oligochaeta (aquatic worms). These six taxonomic groups made up almost 69 percent of organisms (by number) identified from samples in the locale. There were 50 benthic taxa reported as occurring in the samples collected within the 3.5 mile (5.6 km) limit. The average number of taxa per sample in this locale in 2001 was 11.6 taxa. The average number of organisms/square ft (organisms/m²) in this locale in 2001 was reported to be 188 (2,017).

**2002 Benthic Macroinvertebrate Field Sampling Program**

During late spring of 2002 assessments of the benthic macroinvertebrate community were performed at the site of the proposed action (Horseshoe Shoal), Monomoy-Handkerchief Shoal and Tuckernuck Shoal in Nantucket Sound (see Figure 4.2.5-1). All of these areas are located outside the 3.5 mile (5.6 km) limit. These three Nantucket Sound study areas were evaluated taking into consideration specific habitat variables including sand wave presence, sediment type, and water depth. These habitat variables are generally accepted as primary factors that influence benthic community abundance and diversity in Nantucket Sound (Theroux and Wigley, 1998; Zajac, 1998; Colarusso, 2002). Published charts and reports (O'Hara and Oldale, 1987; NOAA Fisheries, 2001), results from geophysical surveys conducted in 2001, and surficial marine sediment classification obtained from vibracores, borings, and benthic grab samples collected in 2001 and 2002 were reviewed in order to characterize conditions across the three areas (Report No. 4.2.5-1).

One benthic sample was collected using a surface grab from each of 33 selected locations (Report No. 4.2.5-1). The sampling locations included benthic habitats such as various sand wave conditions, different sediment types, and differing depths. All areas evaluated did not necessarily contain all of these habitat conditions. Shallow depths were not present at the Monomoy-Handkerchief Shoal Site and sand waves occurred only at the Horseshoe Shoal site. The field sampling program was designed so that statistical comparisons could be made among the physical oceanographic parameters and the benthic organism community composition. Communication with USEPA (Colarusso, 2002) indicated that a minimum of five samples per habitat type would provide sufficient statistical power for the evaluation of differences in benthic resources associated with major habitat types such as sand wave presence, substrate type and depth in each of the three study areas in Nantucket Sound.

The following information is a summary of detailed results of the 2002 Sampling Program found in Report No. 4.2.5-1. Since the 2002 survey was conducted in the spring a comparison could be made to summer surveys conducted in 2001. Information from the Horseshoe Shoal portion of this sampling program is summarized in this section.

For the 2002 sampling program, samples from 12 sampled sites were evaluated and 48 benthic invertebrate taxa from nine different Classes were identified. During the 2002 spring season, data indicated that Horseshoe Shoal supported a macroinvertebrate community that had an average diversity of 9.9 taxa per sample and an average abundance of 842 organisms/square ft (9,060 organisms/m²). Six dominant taxa represented over 90 percent of the macroinvertebrate community at Horseshoe Shoal in 2002, while in comparison. These six taxa represented over 75 percent of the macroinvertebrate community at Horseshoe Shoal in 2001. The most dominant taxon (by number [average number individuals/ m²]) was reported to be Nematoda (roundworms) followed by Ampeliscidae (four-eyed amphipods).

The six dominant taxa at Horseshoe Shoal in the spring of 2002 differed when compared to those dominant in late summer of 2001. Nematoda were more dominant in spring of 2002 than in summer of 2001. Two snail species, *Crepidula convexa* and *Crepidula fornicata* ranked in the top six taxa that were collected during the summer 2001 whereas they were not in the spring 2002 top six taxa. Also, three families of crustaceans were ranked in the six dominant taxa during summer 2001 and only two were so ranked in the spring 2002 sampling effort. These variations may be due to life cycles of these organisms that result in varying seasonal abundance patterns or to annual variability of these populations.

Benthic organisms from sediment depths greater than 5 cm were noted. Some of these organisms are not typically found in the deeper sediments and may have become included with deeper sediment organisms due to sediments from the upper 5 cm of the collected sample passing through the sieve. Even though the residual organisms were present, few organisms were noted in the sediment depths that were greater than 5 cm. This analysis reveals that most of the benthic organisms that occur at Horseshoe Shoal live in the top 5 cm of the substrate. This may be due to the presence of shifting sediments in this area that would have greater potential for burying organisms that are sedentary or deeply embedded (Sanders, 1956; Rhoads et al., 1978). Data analyses indicate that during the late summer 2001 sampling period and the spring 2002 sampling period benthic community abundance and diversity was not significantly different in the Horseshoe Shoal area.

**2003 Benthic Macroinvertebrate and Shellfish Survey of Lewis Bay**

During the summer of 2003, a benthic organism and shellfish sampling program was performed in order to describe shellfish and other benthic organisms that occur in Lewis Bay in the Town of Yarmouth shellfish area, an area that would be crossed by the proposed cable route (Report No. 4.2.5-3). Shellfish and other benthic organisms were sampled at specific locations (see Figure 4.2.5-2) along the proposed route in Lewis Bay with a clam rake, a ¼-inch mesh box sieve, and a manually operated dredge, when appropriate. All sample locations were mapped. The clam rake, box sieved samples, and dredge were each used at each sampling location so that all components of the benthic community could be adequately evaluated. The recreational shellfish bed in Lewis Bay (approximately 600 ft (61 m) in width) will be crossed entirely by jet plow. The 200 ft (61 m) closest to shore, which is landward of the recreational shellfish bed limit is to be crossed by using HDD with the remaining 400 ft (122 m) to be crossed using a jet plow. The cofferdam, and any impacts that may be associated with it, will be located approximately 200 ft from shore and landward of the recreational shellfish bed. Also, for the transition from the seaward terminus of the HDD conduit to the submarine transmission cable system a pre-excavation pit would be required.

The following information is a summary of the detailed results of the 2003 Sampling Program found in Report No. 4.2.5-3. Areas sampled are all located in Massachusetts waters. The benthic macroinvertebrate community in the locale of the Town of Yarmouth's recreational shellfish bed had a variety of organisms including worms, crustaceans, clams and snails. Thirty-one benthic macroinvertebrate taxa from seven taxonomic classes were recorded in samples evaluated from four sites using the three sampling techniques. The sample site located furthest from shore (BGL1A) had the highest overall macroinvertebrate abundance (organisms/square ft [organisms/m²]), as evaluated by the dredge technique. Abundance of large shellfish, including the northern quahog, as evaluated by the clam rake technique, was similar at all four sites.

Of macroinvertebrates found in Lewis Bay, the Polychaeta were the most diversely represented class. Thirteen different taxa were present in dredge and sieved samples combined. *Streblospio benedicti* (mud worm) were most abundant with *Prionospio* spp. (mud worm), Family Syllidae, and Capitellid thread worms commonly occurring. The most abundant class observed using the dredge technique was the Nematoda (round worms) with the Class Oligochaeta also being abundant. The most abundant class of macroinvertebrates in clam rake samples was bivalves with the most abundant species being the northern quahog. *Anadara ovalis* (blood ark) was also commonly found. The density of macroinvertebrates collected in this survey averaged 5,406 individuals/square ft (58,168 individuals/m²) compared to an average of 517 individuals/square ft (5,558 individuals/m²) on Horseshoe Shoal in 2001 and 842 individuals/square ft (9,060 individuals/m²) on Horseshoe Shoal in 2002. The density of macroinvertebrates that were collected in the deeper waters of Lewis Bay in 2001 averaged 188 individuals/square ft (2,017 individuals/m²) which is lower than the densities recorded from Horseshoe Shoal at that time. Comparison with previously collected Nantucket Sound data notes a marked absence of the Order Amphipoda in Lewis Bay during this study. A possible reason for the absence of amphipods in Lewis Bay could be their sensitivity to environmental stresses or disturbances (Pratt, 1973). Many dominant taxa found in Lewis Bay in this study are described as either pollution tolerant, opportunistic in nature, or early colonizers following an environmental disturbance.

**2005 Benthic Macroinvertebrate Field Sampling Program at New Turbine Locations**

During November 2005 the benthic database for the proposed action was updated to obtain additional benthic community information in areas not investigated previously due to a revised turbine layout. The benthic macroinvertebrate community was assessed at four new locations in a manner that was consistent with methods previously established for the 2001 and 2002 field sampling programs in order to maintain consistency among the surveys (Report No. 4.1.1-1).

The following information is a summary of the detailed results of the 2005 Sampling Program found in Report No. 4.1.1-1. Results from the analyses of samples from the four new locations indicated a presence of 20 benthic macroinvertebrate taxa (Report No. 4.1.1-1). The average taxonomic richness for the four sites sampled was 9.5 taxa per sample, with a total taxonomic richness for areas sampled being 20 taxa. Site BG05-04 that is located at a depth of 27 ft (8.2 m) had the highest taxonomic richness with 16 taxa recorded. Site BG05-02 had the lowest taxonomic richness with only 4 taxa recorded at each site. For the four sites sampled the average faunal density was 1,102 individuals/square ft (11,589 individuals/m²) (Report No. 4.1.1-1). Site BG05-04 on Horseshoe Shoal's western edge had the highest faunal density with 1,942 individuals/square ft (20,898 individuals/m²). Sites BG05-02 and BG05-03, which are located at the center and to the north of Horseshoe Shoal, respectively, had the lowest faunal density with 504 individuals/square ft (5,418 individuals/m²). Average density for the four locations was higher than densities reported during the 2001 sampling program (521 individuals/square ft [5,611 individuals/m²]) and during the 2002 sampling program (842 individuals/square ft [9,060 individuals/m²]). These differences may be the result of community shifts expected from differences between seasons sampled with the 2001 and 2002 being late spring and summer samples while the 2005 samples were collected in the fall when the community is dominated by a larger number of smaller organisms (Sanders, 1956).

In the 2005 sample, Nematoda were more abundant than any other group, comprising 70 percent of the total number of individuals/square ft (individuals/m²) of all the samples. Nematoda were dominant in each sample with over 50 percent in BG05-01, BG05-02, BG05-03 and 47 percent in BG05-04. Oligochaeta was the only other taxon that met criteria for being dominant and was 27 percent dominant in sample BG05-04. The gastropod *Crepidula fornicata* made up 17 percent of the sample. At site BG05-01 Platyhelminthes, *Ophelia* spp. and *Scoloplos* spp. had significant individuals/square ft (individuals/m²) with three percent, four percent and two percent of the sample count, respectively. At sample site BG05-02 Platyhelminthes and *Glycera* spp. were present in significant numbers at four percent and three percent of the sample count, respectively. At site BG05-03 Platyhelminthes (four percent) were also present along with *Scoloplos* spp. (five percent) of the sample count. The only taxa identified on the sieve portion of any of the four samples were three specimens of *Macoma balthica* at site BG05-03.

**2005 Macroinvertebrate Survey of Meteorological Tower Colonization**

During June 2005 an assessment was made of the macroinvertebrate community colonizing the meteorological tower installed within the proposed offshore area of the proposed action. The tower platform is supported by three steel pilings that are not identical in size to the proposed monopiles, but have the same smooth steel surface. In addition, scour control mats that are proposed for the monopile foundations protected one of the three pilings. The meteorological tower, installed in April 2003, had been in place for more than two years allowing for a macroinvertebrate community to be established. It was hypothesized that the macroinvertebrate community that became established on the support pilings would be similar to a community that may establish itself on the proposed monopiles.

During the survey observations made by divers indicated that similar macroinvertebrate communities were established on the three support pilings, with distinct colonization patterns at different water depths. Vacuum suction techniques were used to collect three samples. Benthic organisms and other attached material were completely removed from 0.14 square ft (0.013 $m^2$) of surface area from one of the support pilings. A sample was collected from each of three localities: one from an area of the piling that was just above the sea floor, one from within a mid-depth range of the piling, and one just below the low water mark located on the piling.

The following information is a summary of the detailed results of the 2005 Survey of Meteorological Tower Colonization found in Report No. 4.2.5-4. The purpose of this survey was to provide a qualitative assessment of the nature and rate of expected patterns of colonization on the proposed WTG monopiles based on the benthic community colonizing the existing meteorological tower support pilings. The survey results indicated that a benthic macroinvertebrate community similar to the surrounding sea floor community had colonized the support pilings. However, taxa were reported that had not been previously noted in the sandy bottom habitat. Twenty-six taxa, including seven species not observed during other baseline surveys at Horseshoe Shoal, were noted during the macroinvertebrate sampling on the tower support pilings (see Table 4.2.5-2). The seven new species reported included blue mussel (*Mytilus edulis*), sea flea (*Photidae* spp.), sea slug (*Sacoglossa* spp.), mud worm (*Polydora* spp.), large-eyed feather duster worm (*Potamilla reniformis*), purse sponge (*Scypha ciliata*) and a sea spider (*Tanystylum orbiculare*). These new taxa are likely to be in the area of the proposed action, but would be expected to inhabit hard substrates such as rocky shoals or boulders. Average taxonomic richness for the three piling sites that were sampled was 14.3 taxa/sample. Though this sampling effort was limited, it is expected that pilings would support more taxa since they may attract organisms from both the sandy substrate habitat and those that would be attracted to fixed structures. Supporting this conclusion are the results of field observations that noted the most abundant and diverse communities near the base of pilings close to the naturally occurring substrate. The three piling sites sampled had an average faunal density of 106 individuals/square ft (1,145 individuals/$m^2$), lower than values noted from benthic samples evaluated during the 2001 and 2002 surveys (521 individuals/square ft [5,611 individuals/$m^2$] and 842 individuals/square ft [9,060 individuals/$m^2$], respectively).

**Conclusions from Benthic Field Investigations**

From 2001 to 2005 there were 90 benthic samples collected in Nantucket Sound. Each of the dominant benthic habitats that occur in the site of the proposed action area and in surrounding sites was sampled during a variety of seasons. Overall, benthic community composition documented during the studies was consistent with data noted in previous studies in Nantucket Sound, on Georges Bank, and the Southern New England Shelf (Sanders, 1956; Wigley, 1968; Pratt, 1973, Theroux and Wigley, 1998). These earlier studies indicated that the Nantucket Sound benthic community had a lower than average invertebrate density when compared with the rest of the Southern New England Shelf. However, biomass and density were found to be relatively high. Certain benthic taxa are more adapted to the shifting sand substrates that are characteristic of shallower waters. Thus, productive shallow water habitats can support greater densities of these adapted organisms but have lower overall densities compared to more stable, often deeper water benthic habitats.

There is natural variability in most benthic communities since the communities are subject to combinations of biological and physical factors that result in a high degree of environmental variability

(Sanders, 1958; Zajac, 1998). A high sample-to-sample variability in total invertebrate abundance was also found. This supports conclusions of previous research efforts that indicated the Nantucket Sound benthic community was highly variable from one location to another and from one season to another (Wigley, 1968). The patchy nature of "microhabitats" (specific combination of habitat elements in a place that is occupied by an organism for a specific purpose) in terms of parameters like depth, currents, sediment type, light penetration, temperature, availability of food, disturbance, predation and shelter is believed to be a reason for this variability (Sanders, 1956; DeLeuw et al., 1991; Howes et al., 1997).

Results from benthic samples evaluated reveal a link between sediment type, depth, and macroinvertebrate community diversity. Data also showed there was not a link between the above variables and overall macroinvertebrate abundance. The microhabitat variable evaluated that significantly ($P<0.10$) affected macroinvertebrate abundance was presence/absence of sand waves. Unstable sand wave environments are mainly inhabited by motile organisms that can avoid shifting sands (e.g., certain amphipod taxa and the tanaid *Leptognathia ceaca*) or by organisms that are capable of burrowing from beneath shifting sands if they get buried (e.g., certain polychaetes, Nematoda, Oligochaeta, and the bivalve *Tellina agilis*). *Tellina agilis* was the only shellfish collected in a sample from a sand wave. This mollusk has been described as an actively burrowing and mobile bivalve (Gosner, 1978).

Although limited numbers of samples were collected from the meteorological tower support pilings, the survey results indicate the benthic community that colonized them was similar in nature to the nearby sea floor community. Several new taxa noted on the pilings had not been recorded during previous sampling efforts from gravelly, sand or mud substrates. It is likely these new taxa colonized through their planktonic larvae or migrated to the pilings from other stationary hard substrate habitats in the proposed action locale such as rocky shoals or boulders.

### *4.2.5.4 Shellfish Resources*

Review of the scientific literature has indicated that few studies related to shellfish resources have occurred in the proposed action locale and submarine route in Nantucket Sound. Information related to commercial shellfish resources in the larger area of Nantucket Sound is available from NMFS and MDMF. In addition, in Massachusetts, local shellfish constables serve to manage shellfishing activities in each town. Certain areas can be designated by shellfish departments to be used for recreational or family harvesting. Other specified areas may be privately licensed shellfish areas. There may also be areas for grants that are managed privately for certain shellfish species.

Shellfish suitability area information for blue mussel, bay scallop, sea scallop, surf clam, soft shell clam, quahog, and also Yarmouth aquaculture lease areas was obtained from the MassGIS database and is shown in Figure 4.2.2-1, Benthic Habitat Map.

#### 4.2.5.4.1 Massachusetts Department of Marine Fisheries Research Trawls

One source of information for shellfish resources is the MDMF bi-annual research trawls that are designed for collecting fishery-independent information on distribution and abundance of invertebrates and fish in Massachusetts' waters. These trawl surveys have been performed yearly in May and September since 1978, and are based on a stratified random design using depth strata and a 1 square mile nautical grid. Coastal waters are stratified into geographic zones or strata according to depth and area. The pre-determined trawl locations are assigned in proportion to the area of each stratum and are then selected randomly in each stratum. Since timing of the surveys is May and September, this does not allow the surveys to represent abundance and distribution of fish or invertebrates over a whole year. The timing coincides with seasons when adults or juveniles are in the inshore areas. The trawling surveys are also more effective for collection of semi-pelagic and demersal species. Information is available on a Nantucket Sound-wide basis for a 27 year period (Report No. 4.2.5-5).

The review of MDMF trawl information from 1978 to 2004 (see Figures 4.2.5-3 through 4.2.5-6) showed that in the fall resource trawls the knobbed whelk and lady crab were included in the top 10 species by catch weight (Report No. 4.2.5-5). In the fall resource trawls, spider crabs and lady crabs were ranked in the top 10 species by catch number. In the spring resource trawls, spider crabs were ranked in the top 10 species by catch weight. In the spring resource trawls, spider crabs and Atlantic rock crabs were ranked in the top 10 species by catch number.

#### 4.2.5.4.2 Massachusetts Department of Marine Fisheries and National Marines Fisheries Service Commercial Harvest Data

In addition to the research trawls, the MDMF collects information on commercial harvesting of shellfish, lobster, and other "regulated" fisheries, which is maintained through the Management Information Systems and Fisheries Statistics Project. In order to monitor fishery resources in Massachusetts' waters, coastal waters have been divided into statistical areas with Nantucket Sound identified as Statistical Reporting Area 10. Reporting procedures include commercial fishermen submitting catch reports that address several shellfish species, including the lobster, shellfish and conch pot fisheries. A 15-year period (1990 through 2004) of MDMF catches data for available shellfish species from MDMF Area 10 were obtained from MDMF.

For monitoring commercial fishery landings, NMFS separates U.S. coastal waters into statistical areas. With Nantucket Sound designated as Statistical Area 538/Sub-area 075, which is comparable to MDMF Area 10 (see Section 4.2.7.1 for Report No. 4.2.7-1 - figure in Attachment A and figure in Attachment B). Landings information (including certain species of shellfish) from commercial fishermen is reported to NMFS via a mandatory reporting system. These data are called "vessel trip reports (VTR)." The VTR data covering an eleven-year period (1994 to 2004) for available shellfish species in Sub-area 075 were obtained from NMFS. This information was utilized to describe commercial shellfish resources and landings in Nantucket Sound (Report No. 4.2.5-5).

Shellfish landings in the federally-reportable Area 075 between 1994 and 2004 were represented by several species that included conch (whelk), quahogs, scallops and clams. Conch is a general term for several species of whelk such as the knobbed whelk, channeled whelk and lightning whelk that are found in Southern New England waters. The NMFS VTR data indicate several species of conch make up an important fishery in Nantucket Sound. From 1994 through 2004, conch species made up 80 percent of the total annual shellfish landings (see Figure 4.2.5-7). From 1994 through 2004, federally-reportable shellfish harvested in Nantucket Sound totaled approximately 1.8 million lbs (816,466 kg) (see Table 4.2.5-3). Lowest shellfish landings were reported in 1996 (approximately 10,600 lbs [4,808 kg]) and highest shellfish landings were reported in 2001 (approximately 448,000 lbs [203,209 kg]) (Report No. 4.2.5-5).

The fish pot fishery for conch in Nantucket Sound is monitored by MDMF separately from shellfish that are harvested by other methods. From 1992 through 2004 the state-reportable conch landings from conch pots in the Nantucket Sound area totaled approximately 14.6 million lbs (6,622,449 kg) (Report No. 4.2.5-5). Landings information prior to 1992 is not available since catch reports for conch were not required prior to 1992. On an annual basis, state-reported conch landings from pots fished in Nantucket Sound have generally decreased from a high in 1992 (approximately 2 million lbs [907,185 kg]) to a low in 1998 (478,000 lbs [216,817 kg]). Landings have increased since 1998 going from 939,000 lbs (425,923 kg) in 1999 to 1.1 million lbs (498,952 kg) in 2004. During the timeframe from 1998 through 2004 a low of 685,000 lbs (310,711 kg) was reported in 2001. On a seasonal basis, the state-reported conch landings are usually high in June through August (Report No. 4.2.5-5).

State-regulated species of shellfish that are harvested from Nantucket Sound using methods other than fish pots include ocean quahogs, mixed quahog species, sea clams, soft shell clams, bay scallops, sea scallops, mussels and conch. American lobster landings are reported separately. From 1990 through 2004, total landings for the above shellfish species in Nantucket Sound were approximately 27.1 million lbs (12,292,353 kg) (see Table 4.2.5-4). During 1990 and 1992, these state-reported shellfish landings for Nantucket Sound showed an increase from approximately 80,000 lbs (36,287 kg) to approximately 5 million lbs (2,267,962 kg). In 1993, these state-reported shellfish landings decreased and then increased in 1994 to a 10 year high of 7.9 million lbs (3,583,380 kg). In the following years these state-reported shellfish landings in Nantucket Sound decreased in 1999 to 65,000 lbs (29,484 kg), in 2000 to 83,000 lbs (37,648 kg), and in 2003 to 55,000 lbs (24,948 kg) (see Figure 4.2.5-8). Common species harvested over the 15-year period in Nantucket Sound include the sea clam which made up approximately 47 percent of the state shellfish landings during this timeframe. The second most common species were mussels and the third most common species were conchs making up approximately 32 percent and 14 percent, respectively of shellfish reported harvested in Nantucket Sound by state permitees. Quahogs, including ocean quahogs, mixed quahogs, littlenecks and cherrystones, made up approximately 6 percent of the total state-reported shellfish landings. Soft shell clams, bay scallops and sea scallops made up less than 1 percent of the total state shellfish landings during the 15-year timeframe (see Figure 4.2.5-9).

Though northern quahogs (*Mercenaria mercenaria*) have been noted as making up a small percentage of state-reported shellfish landings, they have been reported as an important fishery in Massachusetts (MDMF, 2001) and also to be abundant in the coastal estuaries emptying into Nantucket Sound (MacKenzie, 1997). The MDMF staff (MDMF, 2001) has indicated there is a heavily populated northern quahog area present east of Horseshoe Shoal. A shellfish suitability area for quahogs is shown east of Horseshoe Shoal in Figure 4.2.2-1, Benthic Habitat Map. This locale is called the “quahog grounds” and is described as an area targeted by commercial fishermen (MDMF, 2001).

Bay scallops (*Argopecten irradians*) occur in Nantucket Sound in shallow areas mainly in proximity to seagrass beds. Shellfish suitability areas for scallops along the shoreline in Lewis Bay and along Nantucket Sound shoreline areas in proximity to Lewis Bay are shown in Figure 4.2.2-1, Benthic Habitat Map.

American lobsters (*Homarus americanus*) occur throughout New England. There is a commercial fishery for this species in coastal states from Maine to Delaware. Commercial permits for this species are issued to offshore fishermen (outside of the 3.5 mile [5.6 km] territorial limit) and inshore fishermen (within the 3.5 mile [5.6 km] territorial limit). The MDMF has designated 14 areas in Massachusetts nearshore waters for the reporting of lobster catch. The area of the proposed action is located within MDMF Area 10 that includes Nantucket Sound.

The lobster fishery in Nantucket Sound does not appear to be a major fishery. Massachusetts lobster fishery statistics for 2004 (Dean et al., 2006) reported that the Area 10 (Nantucket Sound) lobster fishery included 0.3 percent (of nearly 9 million lbs [4,082,331 kg]) of the total Massachusetts coastal permit harvest in 2004. Adjacent areas (Areas 9 and 11 through 14) had low yields, each having 5 percent or less of the total harvest. Areas 2 though 8 that are located along the northern coast above Cape Cod Bay had the highest catches in territorial waters.

From 1990 through 2004 the total state-reportable lobster landings for Area 10 (Nantucket Sound) were estimated to be approximately 457,000 lbs (207,292 kg) (see Figure 4.2.5-10). The lobster landings increased from 8,000 lbs (3,629 kg) to approximately 50,000 lbs (22,680 kg) during the timeframe of 1990 through 1993. From 1994 to 1999, lobster landings varied from a low of 28,000 lbs (12,701 kg) to a high of approximately 48,000 lbs (21,772 kg) followed by a decline in 2000 to below 20,000 lbs (9,072 kg). Between 2001 and 2004, for Nantucket Sound the lobster landings stayed at approximately 20,000 lbs (9,072 kg) except in 2002 when landings of approximately 42,000 lbs (19,051 kg) were reported. On a seasonal basis, state-regulated lobster landings increased in June, peaked in July, and declined from August through December (see Figure 4.2.5-11) (Report No. 4.2.5-5).

#### 4.2.5.4.3 Survey of Commercial and Recreational Fishing Activities

Additional information on commercial and recreational shellfishing was obtained as part of a survey of commercial and recreational fishing activities. Five shellfish and coastal officers were interviewed during this survey (Report No. 4.2.5-6).

In Edgartown it was reported that shell fishermen reportedly harvest scallops on both sides of Cape Poge, in outer Edgartown Harbor and along the channel area. It was reported that sometimes littlenecks (small quahogs) and surf clams were harvested on Horseshoe Shoal. It was noted that conch fishermen frequent Horseshoe Shoal. The Edgartown shellfish constable commented that Horseshoe Shoal is not a productive area for lobsters, since it is too sandy.

The Barnstable shellfish officer noted that clamming occurs off Squaw Island, Halls Creek and Dead Neck in the Barnstable waters of Nantucket Sound. The Officer commented that the Vineyard and Nantucket are traditional scalloping grounds and Egg Island north of Point Gammon once had a scallop fishery, and noted that draggers harvest quahogs in beds found four to five years ago off Harwich, Brewster and Chatham. The Officer's comments did not include knowledge of scallops in the Horseshoe Shoal locale.

Based on knowledge of those interviewed, no commercial or recreational harvesting of soft shell clams, razor clams, bay scallops or sea scallops was reported on Horseshoe Shoal. It was reported that conch trapping by fixed gear fishermen does occur on Horseshoe Shoal. One municipal official commented that Horseshoe Shoal was too sandy to support a viable lobster fishery. Of the 41 survey participants (18 commercial fishermen, one commercial fish dealer, eight recreational fishermen, four bait and tackle shop staff, five harbor masters, and the five shellfish and coastal officers) none reported lobstering on Horseshoe Shoal (Report No. 4.2.5-6).

#### 4.2.5.4.4 2003 Shellfish and Benthic Macroinvertebrate Survey of Lewis Bay

During the summer of 2003 shellfish and benthic organism sampling program was performed in order to describe shellfish and other benthic organisms that occur in Lewis Bay in the Town of Yarmouth shellfish area to be crossed by the proposed cable route (Report No. 4.2.5-3). Results of the sampling indicated that the abundance and diversity of shellfish and benthic organisms were similar to previously conducted studies in similar types of areas. Results from this survey were also discussed previously in Section 4.2.5.3.2.

#### 4.2.5.4.5 Municipal Shellfish Resources

Certain towns, including the Town of Yarmouth, have shellfish management programs that involve purchasing seed and adult shellfish for propagation and enhancement of natural shellfish stocks in stretches of waterbodies within the respective town. In cooperation with MDMF, shellfish departments that participate in such programs have a rotating schedule for opening and closing such areas based on water quality information and availability of shellfish.

In the routing from offshore to the Cape Cod shoreline the proposed submarine transmission cable route crosses the 3.5 mile (5.6 km) state jurisdictional limit and enters Town of Yarmouth waters, then enters Town of Barnstable waters at the outer section of Lewis Bay, and proceeds to the inner section of

Lewis Bay back in the Town of Yarmouth and to the proposed landfall site at New Hampshire Avenue in the Town of Yarmouth (see Figure 4.2.2-1, Benthic Habitat Map).

A short section of the submarine transmission cable route passes through jurisdiction of the Town of Barnstable, mostly located in the outer section of Lewis Bay, which has been described as not having substantial recreational or commercial shellfishing harvesting or aquaculture lease areas (Marcotti, 2002). Shellfish expected in this section of Lewis Bay include soft shell clams, quahogs and scallops. Scalloping activity takes place near Egg Island and the Town of Barnstable may open some areas offshore for quahog harvesting (Marcotti, 2002). The Town of Barnstable has no privately-licensed shellfish grants or shellfish propagation projects in the outer section of Lewis Bay. The section of Lewis Bay within the Town of Yarmouth has been described as containing quahogs, soft shell clams, scallops, and limited numbers of eastern oysters (*Crassostrea virginica*). Although there is limited shellfish life in Lewis Bay, quahogs are the most prevalent shellfish species primarily due to the seeding of the recreational shellfish beds. In this section of Lewis Bay shellfish resources occur in privately licensed shellfish grant areas or areas that are managed through the Town of Yarmouth's shellfish propagation program (Caia, 2002).

Several locations in the Town of Yarmouth have designated recreational shellfish areas open only to Town residents for recreational purposes. One such area is within the direct path of the submarine transmission cable route – extending from Colonial Acres east to the Englewood Breakwater (see Figure 4.2.2-1, Benthic Habitat Map). Another such area is located outside of the submarine transmission cable route in the Mill Creek locale. These areas are enhanced with seed shellfish annually through the Town of Yarmouth's shellfish propagation program (Caia, 2002). The Town of Yarmouth's website indicates that current propagation efforts are directed toward restoration of the bay scallop fishery, maintenance of the quahog fishery, re-establishment of historic soft shell clam beds, and re-establishment of the oyster fishery.

The proposed submarine transmission cable route crosses approximately 600 ft (183 m) of the designated recreational shellfish area in Lewis Bay that is a summer relay area for depuration of contaminated shellfish. The contaminated shellfish come from Mount Hope Bay and Fall River and are usually relayed by mid-June and need to remain in the depuration areas for one year. Recreational harvesting is permitted in these areas every other year to correspond with the schedule and cycle of the relay activities (Caia, 2002).

Privately licensed shellfish areas or grants in Lewis Bay privately farmed or managed for shellfish species are located outside the area where the proposed submarine transmission cable is routed (see Figure 4.2.2-1, Benthic Habitat Map).

Classification information on designated shellfish growing areas provided by the Yarmouth Shellfish Constable (Caia, 2002) and on MassGIS data overlays shows that the submarine transmission cable route in Lewis Bay passes through approved shellfish growing areas. The designation shifts to a conditionally approved growing area as the submarine transmission cable route approaches the Yarmouth landfall. The change in classification occurs approximately 600 ft (183 m) from the landfall location. Approved shellfish areas are described as those that allow shellfish harvest for direct human consumption according to local rules and state regulations. Conditionally approved shellfish areas are described as those that allow shellfish harvest when the area is approved as determined by shellfish availability and water quality characteristics.

### *4.2.5.5 Meiofauna and Plankton*

#### 4.2.5.5.1 Meiofauna

Meiofauna are small benthic organisms that range in size from 0.02 to 0.002 inches (0.5 to 0.045 mm). They are found in freshwater and marine environments. The term "meiofauna" refers to the size class transition from micro- to macrofauna. The International Association of Meiobenthologists recognizes 20 phyla of organisms that can be meiofaunal representatives. Of these 20 phyla, five are exclusively meiofaunal. The five phyla include *Gnathostomulida* (jaw worms), *Kinorhyncha* (small marine pseudocoelomate invertebrates), *Loricifera* (small sediment dwelling animals), *Gastrotricha* (free-living acoelomate aquatic worms) and *Tardigrada* (small segmented animals similar to arthropods) (IAM, 2006). The 15 other phyla represented, but not exclusively found, within meiofauna include the following: *Porifera, Placozoa, Cnidaria, Ctenophora, Platyhelminthes, Orthonectida, Rhombozoa, Cycliophora, Acanthocephala, Nemertea, Nematomorpha, Nematoda, Rotifera, Entoprocta, Priapulida, Pogonophora, Echiura, Sipuncula, Annelida, Arthropoda, Onychophora, Mollusca, Phoronida, Bryozoa, Brachiopoda, Echinodermata, Chaetognatha, Hemichordata and Chordata* (IAM, 2006).

Given the small size of these organisms, they are seldom a part of general environmental surveys performed for environmental assessments of proposed actions and are seldom part of resource management activities. However, they can number in the ten to hundreds of thousands per $m^2$ in soft sediments, have reproductive mechanisms that allow them to survive in mobile sand sediments often found in shallow marine environments, and in certain instances, experience large seasonal fluctuations in abundance. For purposes of impact analysis (see discussion in Section 5.3.2.5), previous characterizations of the meiofauna (e.g., Theroux and Wigley, 1998) in the region that includes the area of the proposed action were taken into consideration.

#### 4.2.5.5.2 Plankton

Review of scientific literature suggests there is little existing information that describes plankton communities in Nantucket Sound. Plankton refers to plants (phytoplankton) and animals (zooplankton) that cannot maintain their distribution against movement of water masses and freely drift in the water column. These organisms are generally very small or microscopic, but organisms like jellyfish are sometime considered in the plankton community. Planktonic communities are generally variable in time and place, resulting in a patchy distribution. Zooplankton communities in Nantucket Sound are likely to contain copepods and euphausiids as well as other planktonic crustaceans such as amphipods and isopods. Many species of benthic invertebrates have planktonic egg and larval stages that are also considered within this community. Fish eggs and larvae from spawning of local fish populations would also be found in the Nantucket Sound plankton community, referred to as ichthyoplankton.

Red tide, a traditional but misleading name for a type of Harmful Algal Bloom (HAB), is a phenomenon that occurs when certain species of toxin-producing dinoflagellates become locally abundant. They are of concern because toxins tend to become concentrated in shellfish during HABs and may induce paralytic shellfish poisoning (PSP) in humans. In coastal New England, marine HABs are most often associated with *Alexandrium fundyense* (NOAA-CSCOR, 2006). However, the proposed Nantucket Sound site is unlikely to be the source of this type of HAB because *A. fundyense* cysts may not be retained well by relatively coarse sediments (WHOI, 2006). Dale (1976) reports that cysts from similar dinoflagellate species have settling velocities close to that of silt particles. Thus, they tend to be found in highest concentration in areas of weak currents and silt deposition. They are less likely to be found in shallow, sandy areas subject to strong tidal currents and wave action such as those found throughout the Nantucket Sound site.

### 4.2.6 Marine Mammals

#### *4.2.6.1 Introduction*

This section describes marine mammal species found in the area of the proposed action which are protected under the MMPA. Threatened or endangered marine mammals protected under the federal ESA are presented in Section 4.2.9 and in the Biological Assessment (BA) in Appendix G. The information contained in this section was obtained from literature review, agency consultations, and site investigations.

All marine mammals are protected under the MMPA (16 U.S.C. §§ 1361 *et seq.*). One duty of the MMPA is to monitor populations of marine mammals with the goal of keeping populations at optimum levels. This responsibility falls to NOAA Fisheries and FWS. If studies show a population falls below its optimum level, the population is designated as "depleted." In such case a conservation plan is developed to guide research and management actions to restore the population to healthy levels.

The MMPA also established a moratorium, with certain exceptions, on the taking of marine mammals in U.S. waters and by U.S. citizens on the high seas, and on the importing of marine mammals and marine mammal products into the United States.[13] The MMPA allows the incidental "taking" of marine mammals for certain specified activities provided the taking is of small numbers and would result in a negligible impact on marine mammals.[14] These "incidental take" authorizations, in the form of either a Letter of Authorization or an Incidental Harassment Authorization (IHA), require that either regulations or a proposed IHA be published in the Federal Register outlining the methods and geographical region of taking, the means of limiting adverse impacts on the species or stock and its habitat, and requirements for monitoring and reporting of any proposed activity. Public comments are then received on these proposed actions before NOAA Fisheries or FWS finalizes their regulations or IHA.

After initially reviewing the proposed action under consideration for the Cape Wind proposal, MMS determined that there would be a potential for the taking of marine mammals, most likely by incidental acoustic harassment, and therefore advised the applicant that the applicant should discuss seeking MMPA authorization with NOAA Fisheries. The applicant has since discussed the need for an MMPA authorization with NOAA Fisheries and has informed MMS that it intends to seek authorization 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.

There is also a prohibition under the Endangered Species Act (ESA) for the taking of listed marine mammals without authorization known as an Incidental Take Statement (ITS). NOAA Fisheries will not issue this ESA ITS for listed marine mammal species without the applicant first obtaining authorization under the MMPA. Therefore, MMS will also require that the ESA ITS be in place before commencing any activities under MMS authorization which might result in the taking of a listed marine mammal.

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[13] The term "high seas" is defined under the U.N. Convention on the Law of the Sea to mean "…all parts of the sea that are not included in the exclusive economic zone, in the territorial sea or in the internal waters of a State, or in the archipelagic waters of an archipelagic State."

[14] Under the MMPA, section 101(a) (5) allows the incidental, but not intentional, "taking" by U.S. citizens engaged in activities other than commercial fishing of small numbers of marine mammals if, after notice and opportunity for public comment, NOAA Fisheries Service determines that appropriate regulations have been met. The Incidental Take Authorization Office of Protected Resources – NOAA Fisheries webpage http://www.nmfs.noaa.gov/pr/permits/incidental.htm

Finally, both the MMPA authorization and the ESA ITS will include a suite of mitigation, monitoring and reporting measures meant to minimize or eliminate the potential for taking. MMS has also identified measures, as outlined in Section 9.3.5.6. These MMS measures may be similar or differ from those required under the ESA and MMPA. However, any measures contained within an MMPA or ESA authorization, if issued, that are more conservative than those measures built into this proposed action by MMS will take precedence.

**Studies Completed**

Review of scientific literature, including stock assessment reports, and consultation with resource management agencies, suggest that few studies of protected whale species have been conducted within Nantucket Sound. A comprehensive literature search targeting protected whale, seal, and sea turtle species in Nantucket Sound and acoustical impacts to marine mammals and sea turtles was conducted to obtain information on protected marine species in Nantucket Sound and potential impacts of the proposed action to these resources. In addition, staff and researchers from the Protected Resources Branch at the NOAA Fisheries Northeast Fisheries Science Center, the Sea Turtle Stranding and Salvage Network, the Provincetown Center for Coastal Studies, and the University of Rhode Island, were contacted by the applicant to obtain additional stock assessment, sighting, stranding, and population studies information. The information gathered during this research is the best available scientific and commercial information and is used to determine the potential impacts of the proposed action in Section 5.3.2.6.

### *4.2.6.2 Resource Characterization*

Marine mammals that are protected under the MMPA (but not the ESA) and may occur in the waters of Nantucket Sound are described in the following Section 4.2.6.2.1 and 4.2.6.2.2. Threatened or endangered marine mammals protected under the federal ESA are presented in Section 4.2.9 and in the BA in Appendix G.

#### 4.2.6.2.1 Pinnipeds

A detailed evaluation was performed for two pinniped species that are most likely to occur in the vicinity of the area of the proposed action: the gray seal (*Halichoerus grypus*) and the harbor seal (*Phoca vitulina*) (Report No. 4.2.6-1). Both pinniped species are protected under the MMPA. The gray seal was previously listed as a species of special concern by the Commonwealth of Massachusetts. The Massachusetts ESA prohibits the "taking" of any rare plant or animal species listed as endangered, threatened, or of special concern by the Massachusetts Division of Fisheries & Wildlife (M.G.L c.131A and regulations 321 CMR 10.00). In addition, the harp seal (*Phoca groenlandica*) and hooded seal (*Cystophora cristata*) are discussed, as they may occur in the vicinity of the site of the proposed action and are also protected under the MMPA.

The population status and trends, seasonal distribution, food and feeding behaviors, and known disturbance and mortality factors are described below, and impacts are discussed in Section 5.3.2.6. Detailed discussions of the potential impacts of Project construction/decommissioning and operation/maintenance to gray and harbor seals can be found in the Pinniped Assessment (Report No. 4.2.6-1).

**Gray Seal (*Halichoerus grypus*)**

The Western population of the gray seal extends from New England to Labrador and is centered in the Sable Island area of Nova Scotia and breeds primarily at Sable Island and on pack ice in the Gulf of Saint Lawrence (NMFS, 2001). Gray seals inhabit temperate and sub-arctic waters, and, in the United States are found along the east coast from Maine to Long Island Sound, New York living on remote, exposed islands, shoals and unstable sandbars. They are relatively large, and may be gray, dark brown or even black in colorings with irregular spotting patterns. Gray seals can live as long as 30 to 40 years, with males reaching sexual maturity around six years and females at three years. While breeding, gray seals may live in loose colonies but generally are gregarious with no regular migratory seasons or patterns. Gray seals have an extensive fish diet, and forage at depths up to at least 230 ft (70 m) (Katona et al., 1993).

Gray seals have two known breeding and pupping grounds in Nantucket Sound at Monomoy and Muskeget Islands (approximately 12 miles [19.4 km] and 8 miles [13 km], respectively, from the proposed action area). Though Monomoy and Muskeget Islands have been identified as habitat for year-round breeding populations (Waring et al., 2006), winter and spring use of these areas is highest (NHESP, 2002). Gray seals presently use Muskeget Island and Monomoy National Wildlife Refuge within Nantucket Sound as an area to give birth and raise their pups. Since there is no defined migratory behavior for gray seals, a large portion of the population may be present in Nantucket Sound year-round, although the actual numbers are not as plentiful as harbor seals. Generally, there is some adult seal movement north during spring and summer out of Nantucket Sound to the waters of Maine and Canada for pupping, as seen with harbor seals (Waring et al., 2006).

The gray seal is protected under the MMPA but is not considered a strategic stock[15] (Waring et al., 2006). Available data are insufficient to estimate the size of the entire western North Atlantic gray seal population, but estimates are available for the Sable Island, Maine coast and Muskeget and Monomoy Island populations (NMFS, 2001). The Muskeget and Monomoy population was estimated at 2,010 in the spring of 1994 (Rough, 1995) and rose to 5,611 by the spring of 1999 (Barlas, 1999). Gray seal counts from winter/spring in 2002 at Monomoy, Muskeget, and Tuckernuck Islands in Nantucket Sound (approximately 14.6, 8.5, and 10.5 miles [23.5, 13.7, and 16.9 km] respectively from the proposed action site) showed 1,599, 16, and 1,192 individuals respectively (Wood, unpublished data). Incidental observations of seals were recorded during avian surveys which were conducted independently by both the proposed action team and the Massachusetts Audubon Society (MA Audubon). While these surveys are not direct observations of seals in the proposed action area and Nantucket Sound, they are used here to present a general overview of the presence of seals in the vicinity of the proposed action. Between May 2002 and February 2004 the proposed action team conducted approximately 47 aerial avian surveys in Nantucket Sound, with particular focus in the area of the proposed action. During the three years of surveys, approximately 26,873 seals were observed throughout Nantucket Sound; however the seals were not identified to the species level. Between June 2003 and April 2005, MA Audubon conducted 55 aerial avian surveys to observe tern breeding and migration patterns and winter waterfowl activities in Nantucket Sound, with specific attention paid to the proposed action area. A three-year total of approximately 396 seals were incidentally observed during these surveys throughout Nantucket Sound, with more heavy concentrations near the Muskeget and Monomoy Island breeding colonies, rather than concentrated in the approximate area of the proposed action.

While little is officially known about the natural causes of mortality for gray seals, major causes of human-induced mortality include marine pollution, habitat destruction, and commercial fishery-related drowning. For the period 2001 to 2004, the total estimated human caused mortality and serious injury to gray seals was 371 per year, of which 228 deaths are attributable to U.S. fisheries (specifically the Northeast multispecies sink gillnet fishery). Between 2001 and 2004, 279 gray seal strandings were recorded, extending from Maine to North Carolina (Waring et al., 2007). In 2004 alone there were 100

[15] Under the MMPA, the term “strategic stock” means a marine mammal stock - (A) for which the level of direct human-caused mortality exceeds the potential biological removal level; (B) which, based on the best available scientific information, is declining and is likely to be listed as a threatened species under the ESA of 1973 within the foreseeable future; or (C) which is listed as a threatened species or endangered species under the ESA of 1973 (16 U.S.C. 1531 et seq.), or is designated as depleted under this Act.

recorded strandings, ten of which showed signs of human interaction as a cause of mortality, (i.e., fishery interactions, power plant entrainments, oil spills, shooting, boat strikes, and other sources) (Waring et al., 2007). Of the total strandings, 154 were reported to occur in Massachusetts (Waring et al., 2007). During the period of September 2005 through August 2006, the Cape Cod Stranding Network (CCSN) reported approximately 30 gray seal strandings on the shores of Cape Cod and on the south coast of Massachusetts, with the major cause attributed to entanglement in marine debris and boat strike (CCSN Annual Report, 2006).

**Harbor Seal (*Phoca vitulina*)**

Harbor seals (*Phoca vitulina*), or the common seal, are found in the northern Atlantic Ocean and adjoining seas above 30°N (Waring et al., 2007), and is the most abundant pinnipeds on the east coast of the United States. Harbor seals commonly occur in coastal waters and coastal islands, ledges and sandbars. Harbor seals can be identified from its short, concave muzzle, which has a slightly upturned tip, and a broad V-shaped nostril. In addition, the eye of the harbor seal is equidistant between the nose and the ear opening. Harbor seals range in color from bluish gray with small dark spots to tan, brown, black or even reddish in color. Maturity is reached at five to six years for males and three to four years for females, and they have been known to live as long as from 30 to 40 years (Katona et al., 1993). Most of the harbor seal's diet consists of fish and invertebrates found within the Nantucket Sound area, but during late summer months they move offshore to deeper waters presumably for offshore fish migrations.

Harbor seals spend the late spring, summer, and early fall between New Hampshire and the Arctic where they breed and care for newly born pups. A general southward movement from the Bay of Fundy to southern New England waters occurs in fall and early winter, mostly consisting of juveniles and young adults. After overwintering in southern New England waters, including Nantucket Sound, the vast majority of the population migrates in the spring to northern waters for pupping season. No pupping areas have been identified in southern New England. While the greatest summer concentrations of harbor seals area long the coast of Main, harbor seals can occur year round in waters around Cape Cod and Nantucket Sound (Payne and Selzer, 1989).

The harbor seal is protected under the MMPA, but is not considered a strategic stock (Waring et al., 2007). The best estimate of abundance for harbor seals is 99,340 based on surveys performed along the Maine Coast in May and June of 2001 (Waring et al., 2007).

While little is officially known about the natural causes of mortality for harbor seals, major causes of human-induced mortality include marine pollution, habitat destruction, and fishery-related drowning. For the period of 2001 to 2005, it is estimated that 893 harbor seals were killed or seriously injured each year in relation to human activities, mainly due to fishery practices, boat strikes, power plant entrainment, shooting, and loss of habitat (Waring et al., 2007). The total estimated average fishery-related mortality or serious injury in the by commercial fisheries, including the Northeast Sink Gillnet, Mid-Atlantic Gillnet and Northeast Bottom Trawl the period of 2001 to 2005 was 882 harbor seals (Waring et al., 2007). During the period 2001 to 2005 there were 1,717 recorded strandings of harbor seals along the U.S. Atlantic coast, with 503 strandings recorded in Massachusetts (Waring et al., 2007), the strandings may be attributed to vessel strikes, fishing gear entanglement, entrainment in power plant intakes, oils spills, storms, abandonment, and disease. Between 2002 and 2003, a total of 217 harbor seal strandings were reported in Massachusetts (Waring et al., 2007). During the period of September 2005 to August 2006, the Cape Cod Stranding Network (CCSN) reported approximately 45 harbor seal strandings on the shores of Cape Cod and on the south coast of Massachusetts, with the major cause attributed to entanglement in marine debris and boat strike (CCSN Annual Report, 2006).

**Harp Seal (*Phoca groenlandica*)**

Harp seals (*Phoca groenlandica*) occur throughout much of the north Atlantic and Arctic Oceans (Waring et al., 2007). Adult harp seals have a gray coat, and females are typically larger than males. Males may reach maturity between 4 and 5 years, while a female reaches sexual maturity at 6 to 7 years old. They can live to be 30 to 35 years old, feeding off of fish and crustaceans. They tend to be gregarious, living in dense groups during breeding season.

The harp seal has been sighted in winter and spring months at the extreme southernmost reaches of its range from mid-Atlantic waters through New England (Waring et al., 2007). The largest of three stocks of harp seals is the eastern Canadian stock, with breeding herds off the coasts of Newfoundland and Labrador, and in the Gulf of St. Lawrence. The other two stocks occur off the coasts of the former Soviet Union and Greenland.

The harp seal is protected under the MMPA but is not considered a strategic stock (Waring et al., 2007). A variety of methods are used to estimate harp seal population sizes including aerial surveys and mark-and-recapture surveys (Waring et al., 2007). The best estimate of the North Atlantic harp seal population based on modeling from the surveys is 5.9 million individuals (Waring et al., 2007).

The estimated annual human caused mortality rate for harp seals for the period 2001 to 2005 was 447,442 individuals (Waring et al., 2007). There were 447,365 recorded deaths from Canadian based fishery related incidental catch and 73 from U.S. observed fisheries (Waring et al., 2007). During the period 2001 to 2005 there was a total of 816 recorded standings along the U.S. Atlantic coast, with 396 strandings recorded in Massachusetts (Waring et al., 2007). During the period of September 2005 to August 2006, the Cape Cod Stranding Network (CCSN) reported approximately 25 harp seal strandings on the shores of Cape Cod and on the south coast of Massachusetts, with the major cause attributed to entanglement in marine debris and boat strike (CCSN Annual Report, 2006).

**Hooded Seal (*Cystophora cristata*)**

The hooded seal (*Cystophora cristata*) occurs throughout much of the north Atlantic and Arctic Oceans, in deeper water than other seals are typically found. Hooded seals have a black face and a bluish-grey coat, lighter on the sides and front, with irregular dark patches scattered over the body and the males have a distinguishable inflatable crest on their forehead. Males reach maturity at five to seven years and females reach maturity at three to six years, with life expectancies of 30 to 35 years of age. Hooded seals feed in deeper waters, and their diet consists of fish and larger invertebrates. Hooded seals are highly migratory, and have been occasionally sighted as far south as Puerto Rico. In recent years, they have been sighted with increasing frequency in waters from Maine to Florida, in the winter and spring months, especially from January to May (Waring et al., 2007).

The hooded seal is protected under the MMPA, but is not considered a strategic stock (Waring et al., 2007). Two stocks occur in the northwest Atlantic; one stock has breeding grounds in the Davis Straight off of Newfoundland, and the second stock has breeding areas off the coast of Newfoundland and the Gulf of St. Lawrence. Surveys of these areas were conducted in 2005 to estimate the total population of hooded seals. Total pup production in the Northwest Atlantic was 116,900 (Waring et al., 2007). Using pup production estimates and making assumptions about the life histories of hooded seals, results in an estimated population size of 592,100 individuals in 2005 (Waring et al., 2007).

For the period 2001 to 2005 the total estimated human-caused mortality of hooded seals is 5,199 (Waring et al., 2007). The average annual estimated fishery-related mortality or serious injury to this stock in U.S. waters for the period of 2001 to 2005 is 25 hooded seals (Waring et al., 2007). Incidental bycatch of hooded seals has been observed in the Northeast multispecies sink gillnet fishery, and resulted in an estimated 25 deaths (Waring et al., 2007). Commercial harvest of hooded seals is not allowed in the Gulf of St. Lawrence (below 50°N) and in the Davis Strait (Waring et al., 2007). For the period 2001 to 2005 there was a total of 138 recorded strandings in U.S. waters, with 53 occurring in Massachusetts waters (Waring et al., 2007). During the period of September 2005 to August 2006, the Cape Cod Stranding Network (CCSN) reported approximately 10 hooded seal strandings on the shores of Cape Cod and on the south coast of Massachusetts, with the major cause attributed to entanglement in marine debris and boat strike (CCSN Annual Report, 2006).

#### 4.2.6.2.2 Cetaceans

The population status and trends, seasonal distribution, food and feeding behaviors, and known disturbance and mortality factors for those cetacean species that can be found in the vicinity of the area of the proposed action are summarized below.

**Atlantic White-sided Dolphin (*Lagenorhynchus acutus*)**

The Atlantic white-sided dolphin (*Lagenorhynchus acutus*) occurs in temperate and polar waters in the North Atlantic, typically around the continental shelf to the 100 m (328 ft) isobath. These animals have black coloring on their dorsal side, with a yellow stripe on their lower dorsal area. Females reach sexual maturity at between 6 and 12 years, and males between 7 and 11 years. Individuals are known to live for up to 22 years (males) and 27 years (females). Their main diet consists of fish such as herring and mackerel and squid (Minasian and Balcomb, 1984; Leatherwood et al., 1982; Ellis, 1982).

In the western North Atlantic, Atlantic white-sided dolphins are believed to form three stocks, the Gulf of Maine stock, the Gulf of St. Lawrence stock, and the Labrador Sea stock. The Gulf of Maine stock ranges from Hudson Canyon to Georges Bank and in the Gulf of Maine to the Bay of Fundy (Waring et al., 2007). Atlantic white-sided dolphins of the Gulf of Maine Stock may occur in Nantucket Sound throughout the year but in higher numbers from June until September.

The Atlantic white-sided dolphin is protected under the MMPA, but is not considered a strategic stock (Waring et al., 2007). The best available estimate for the abundance of the Gulf of Maine stock of white-sided dolphins is 17,594 individuals based on aerial surveys conducted in August 2006 from the Southern Gulf of Maine to the upper Bay of Fundy to the Gulf of St. Lawrence (Waring et al., 2007).

The total U.S. fisheries-related mortality estimate to the Gulf of Maine stock of the western Atlantic white-sided dolphin for the period of 2001 to 2005 was 350 dolphins (Waring et al., 2007). Incidental bycatch has been observed in the Northeast sink gillnet fishery, the mid-Atlantic coastal gillnet fishery, the pelagic drift gillnet fishery, the North Atlantic bottom trawl fishery, and the Atlantic squid, mackerel, and butterfish trawl fisheries (Waring et al., 2007). During the period 2001-2005, there were a total of 277 strandings recorded in U.S. waters, with a total of 222 strandings recorded in Massachusetts alone (Waring et al., 2007). Mass strandings of Atlantic white-sided dolphins are common and may involve over 100 animals (Waring et al., 2007). Several mass strandings have occurred in Massachusetts waters in April 2001 (6 animals), March 2002 (31 animals), January 2003 (4 animals), April 2003 (28 animals), November 2003 (4 animals), February 2005 (8 animals) April 2005 (6 animals), May 2005 (2 animals) and December 2005 (2 animals) (Waring et al., 2007). During the period of September 2005 to August 2006, the Cape Cod Stranding Network (CCSN) reported approximately 60 Atlantic white-sided dolphin strandings on the shores of Cape Cod and on the south coast of Massachusetts (CCSN Annual Report, 2006).

### Striped Dolphin (*Stenella coeruleoalba*)

The striped dolphin (*Stenella coeruleoalba*) is distributed worldwide in temperate, tropical, and subtropical seas. They are distinguishable with their pink underside, and bands that run down their dorsal side. Adults may grow to 8 ft (2.4 m) (females) or 8.5 ft (2.6 m) (males) and weigh 330 lbs (150 kg) (female) or 350 lbs (160 kg) (male). Striped dolphins reach maturity between 7 and 12 years, and may live to between 55 and 60 years. Their main diet is small pelagic fish and squid.

In the western North Atlantic, striped dolphins occur from Nova Scotia south into the Caribbean and the Gulf of Mexico, frequently in continental shelf waters along the 3, 281 ft isobaths (1,000 m) (Waring et al., 2007).

The striped dolphin is protected under the MMPA, but is not considered a strategic stock (Waring et al., 2007). The best available estimate based on a June to August 2004 survey for the abundance of the North Atlantic striped dolphin is 94,462 for the entire eastern U.S. and Canadian coast, and 52,055 individuals from Maryland to the Bay of Fundy (Waring et al., 2007).

From 2001 to 2005 there were no reported fisheries-related mortalities of striped dolphins (Waring, et al., 2007). Incidental bycatch has been observed in the pelagic drift gillnet fishery and the North Atlantic bottom trawl fishery, but no mortalities or serious injuries have recently been documented in any U.S. fishery (Waring et al., 2007). From 2001 to 2005, 51 striped dolphins were found stranded in U.S. waters from Maine to Florida for unknown reasons (Waring et al., 2007).

### Short-beaked Common Dolphin (*Delphinus delphis*)

The short-beaked common dolphin (*Delphinus delphis*) is distributed worldwide in temperate, tropical, and subtropical seas. Their back is dark gray-to-black from the top of the head to the tail. Common dolphins can reach lengths from 7.5 to 8.5 ft (2.3 to 2.6 m) and weigh as much as 297 lbs (135 kg). They travel in small groups and frequently gather into large schools. Sexual maturity is reached at three to four years of age or when they reach 6 to 7 ft in length (1.8 to 2.1 m). The common dolphin feeds on squid and small schooling fish (Evans, 1994; Heyning and Perrin, 1994; Klinowska, 1991).

In waters off the northeastern United States., short-beaked common dolphins are associated with Gulf Stream features and are widespread from Cape Hatteras to Georges Bank over the 656 to 6,561 ft (200 to 2,000 m) isobaths (Waring et al., 2007). The short-beaked common dolphin migrates onto Georges Bank, the Scotian Shelf, and the continental shelf off Newfoundland in summer and autumn months.

The short-beaked common dolphin is protected under the MMPA and is considered a strategic stock (Waring et al., 2007). The best estimate from August 2006 for the abundance of the short-beaked common dolphin off the U.S. and Canadian Atlantic coasts is 84,000 (Waring et al., 2007).

The total annual fisheries-related mortality estimate for the period of 2001 to 2005 was 151 short-beaked common dolphins (Waring et al., 2007). Incidental bycatch was been observed in the pelagic drift gillnet fishery, the pelagic pair trawl, the pelagic longline fishery, the mid-Atlantic coastal gillnet fishery, the North Atlantic bottom trawl fishery, the Northeast multi-species sink gillnet fishery, and the Atlantic squid, mackerel, and butterfish trawl fisheries (Waring et al., 2007). During the period of 2001 to 2005, 323 short-beaked common dolphin strandings were reported in United States from Maine to Florida (Waring et al., 2007). Mass strandings waters occurred within Massachusetts in 2002 (9 dolphins) and 2005 (7, 5, 25 and 4 dolphins) (Waring et al., 2007). During the period of September 2005 to August 2006, the Cape Cod Stranding Network (CCSN) reported approximately 130 short-beaked common dolphin strandings on the shores of Cape Cod and on the south coast of Massachusetts, with the major cause attributed to entanglement in marine debris and boat strike (CCSN Annual Report, 2006).

### Harbor Porpoise (*Phocoena phocoena*)

The harbor porpoise (*Phocoena phocoena*) is primarily an inshore species. They are small rotund cetaceans, with grey coloring. They reach a maximum length of 6 ft (1.9 m) and do not weigh more than 130 lbs (60 kg). Harbor porpoises reach sexual maturity around three to four years. They can live alone, in pairs, or in larger groups. Their main diet is small spine-less fish (Minasian and Balcomb, 1984; Ellis, 1984; Leatherwood et al., 1982).

During the summer, harbor porpoises are concentrated in the northern Gulf of Maine and the southern Bay of Fundy region, generally in waters less than 492 ft (150 m). This stock of harbor porpoises, which migrates south into the mid-Atlantic region, is considered one population, separate from three other distinct populations in the Gulf of St. Lawrence, Newfoundland, and Greenland areas (Waring et al., 2007). During fall and spring months, harbor porpoises are widely distributed from New Jersey to Maine. Low densities of harbor porpoises are found in waters off New York and north to Canada in the winter. No specific migratory routes to the Gulf of Maine/Bay of Fundy region have been identified.

The harbor porpoise is protected under the MMPA, and is considered a strategic stock (Waring et al., 2007). The best estimate for the abundance of the Gulf of Maine/Bay of Fundy population is 89,504 harbor porpoises, based on surveys performed in August 2006 from the Southern Gulf of Maine to the upper Bay of Fundy to the Gulf of St. Lawrence (Waring et al., 2007).

The total annual estimated average human-caused mortality for harbor porpoises is 734 per year (Waring et al., 2007). The average annual mortality for the period of 2001 to 2005 was estimated at 652, attributable to U.S. fisheries (Waring et al., 2007). Mortality has occurred in the U.S. Northeast sink gillnet fishery, the mid-Atlantic coastal gillnet fishery, and in the Canadian Bay of Fundy groundfish sink gillnet and herring weir fisheries. Other human-induced mortality may occur from hunting in some areas of the western North Atlantic. During the period of 2001 to 2005, 604 harbor porpoise strandings were reported from Maine to North Carolina, 218 of which occurred in Massachusetts (Waring et al., 2007). During the period of September 2005 to August 2006, the Cape Cod Stranding Network (CCSN) reported approximately 20 harbor porpoise strandings on the shores of Cape Cod and on the south coast of Massachusetts (CCSN Annual Report, 2006).

### Long-finned Pilot Whale (*Globicephala melas*)

The long-finned pilot whale (*Globicephala melas*) occurs along the edge of the U.S. continental shelf in the winter and early spring. A second species of pilot whale, the short-finned pilot whale (*Globicelphala macrorhynchus*), also occurs in the western North Atlantic. Difficulty distinguishing the two species in the field prevents separate abundance and mortality estimates. They are generally dark colored, with a distinguishable rounded head. The males are larger than the females reaching 20 ft (6.1 m) while females typically measure 16 ft (4.9 m). Males may reach sexual maturity at about 12 years of age and females reach sexual maturity at about 6 to 7 years of age. Pilot whales typically feed on squid, but have been known to feed on fish (Bernard and Reilly, 1999; Olson and Reilly, 2002).

The long-finned pilot whale primarily occurs north of mid-Atlantic waters. Distribution of this species is widespread, ranging from North Carolina to Africa and north to Iceland, Greenland, and the Barents Sea (Waring et al., 2007). Further stock definition is under development.

The long-finned pilot whale is protected under the MMPA, and is currently considered a strategic stock (Waring et al., 2007). The best available estimate based on 2006 aerial surveys for the abundance of both pilot whale species in the Western North Atlantic is 26,535 individuals (Waring et al., 2007).

The average annual fisheries-related mortality estimate for the period of 2001 to 2005, including both species, is 7 pilot whales (Waring et al., 2007). Incidental bycatch has been observed in the pelagic drift gillnet fishery, the pelagic longline fishery, the pelagic pair trawl fishery, the North Atlantic bottom trawl fishery, the squid, mackerel, and butterfish trawl fisheries, and the Nova Scotia trawl fisheries. Mass strandings are common in pilot whales; during the period of 2001 to 2005, 139 long-finned pilot whales were stranded between Maine and Florida, including two mass strandings in Massachusetts waters of 11 and 57 animals in 2000 and 2002 respectively (Waring et al., 2007). While the causes for these strandings are uncertain, there are several hypothesized causes including changes in the earth's magnetic fields, exposure to pollution and toxins through bioaccumulation. During the period of September 2005 to August 2006, the Cape Cod Stranding Network (CCSN) reported approximately 20 pilot whale strandings on the shores of Cape Cod and on the south coast of Massachusetts, (CCSN Annual Report, 2006).

**Minke Whale (*Balaenoptera acutorostrata*)**

Minke whales (*Balaenoptera acutorostrata*) occur throughout polar, temperate, and tropical waters. The minke is counter-shaded-black to dark gray on top, white below. They are a small species, males averaging 26 ft (8 m) and females measuring 27 ft (8.2 m). Sexual maturity is reached at 7 or 8 years. Minke whales feed on small schooling fish and some copepods (Minasian and Balcomb, 1984; Ellis, 1982; Leaterwood and Reeves, 1983).

The minke whale is the third most abundant great whale in the U.S. Atlantic Exclusive Economic Zone (EEZ) (CeTAP, 1982). Minke whales off the east coast of the U.S. are part of the Canadian east coast population, one of four minke populations recognized in the North Atlantic. The range of this population extends south from Canada to the Gulf of Mexico, but distribution is primarily concentrated in New England waters, with most sightings occurring during spring and summer months.

The minke whale is protected under the MMPA, but is not considered a strategic stock (Waring et al., 2007). The best available current abundance estimate for minke whales based on aerial surveys performed off the Canadian Coast from the Gulf of Maine to the Gulf of St. Lawrence in 2006 is 3,312 whales (Waring et al., 2007). This species is found in open seas primarily over continental shelf waters, but occasionally enters bays, inlets, and estuaries.

Minke whale incidental catches have been observed in U.S. waters in the mid-Atlantic coastal gillnet fishery, the Gulf of Maine and mid-Atlantic lobster trap/pot fishery, and the Atlantic tuna purse seine fishery. Not all incidental catches have resulted in mortality. The annual mortality estimate from these human interactions for the period of 2001 to 2005 is 2.6 minke whales per year, with 2.2 deaths attributable to U.S. fishery-related incidents (Waring et al., 2007). Other human-induced mortality occurs from hunting in some areas of the North Atlantic, and from collisions with vessels, although during the period of 1999 to 2003 no collisions were reported, however there was one report of vessel strike in each of the years 2004 and 2005 (Waring et al., 2007). During October 2003 an 'Unusual Mortality Event' was declared, when an abnormal increase in minke whale mortalities was reported; from September 11 to September 30, nine minke whales were found stranded with no known causes (Waring et al., 2007). Since then the number of minke whale mortalities has returned to previous levels. During the period of September 2005 to August 2006, the Cape Cod Stranding Network (CCSN) reported approximately 1 minke whale stranding on the shores of Cape Cod and on the south coast of Massachusetts (CCSN Annual Report, 2006).

**Atlantic Spotted Dolphin (*Stenella frontalis*)**

Atlantic spotted dolphins (*Stenella frontalis*) are distributed in tropical and warm temperate waters of the western North Atlantic. There are two species of spotted dolphin in the Atlantic Ocean, the Atlantic spotted dolphin and the pantropical spotted dolphin (*S. attenuata*) (Waring et al., 2005). They are covered in spots, are typically dark colored with a darker dorsal then ventral side. They average 7 ft (2.1 m) in length, and reach maturity at 6 to 8 years. They are highly social and can be found in large herds numbering in the hundreds or sometimes thousands. Spotted dolphins feed on a variety of fish and squid found near the surface (Minasian and Balcomb, 1984; Leatherwood and Reeves, 1983).

The Atlantic spotted dolphin occurs in two forms, possibly two sub-species; the large, heavily spotted form inhabits the continental shelf and is usually found inside or near the 656 ft (200 m) isobath, and the smaller, less spotted island and offshore form (Waring et al., 2005). The Atlantic spotted dolphin is found from Southern New England to Venezuela, and is widely distributed on the continental shelf, along the continental shelf edge, and offshore over the deep ocean off the northeast U.S. coast (Waring et al., 2005).

The Atlantic spotted dolphin is protected under the MMPA but is not considered a strategic stock (Waring et al., 2005). The best available estimated population size for the Atlantic spotted dolphins from Maryland to the Bay of Fundy, including both forms, is 3,578 individuals, while the estimates of the population from Florida to the Bay of Fundy is 50,978 individuals (Waring et al., 2005). Given their distribution range, it is possible that Atlantic spotted dolphins may occur in Nantucket Sound.

There were no reports of fishery-related mortality or serious injury to the Atlantic spotted dolphin during 1999 and 2003 (Waring et al., 2005). Incidental bycatch has recently been observed in the pelagic drift gillnet fishery, the pelagic longline fishery, the pelagic pair trawl fishery, the North Atlantic bottom trawl fishery, the squid, mackerel, and butterfish trawl fisheries, and the Nova Scotia trawl fisheries. During the same period, 17 Atlantic spotted dolphins were stranded between Massachusetts and Florida (Waring et al., 2005). None of these strandings had evidence of human interaction.

**Risso's Dolphin (*Grampus griseus*)**

Risso's dolphin (*Grampus griseus*) has a worldwide distribution in tropical to warm temperate waters. They are robust with a rounded head, and typically have a light gray coloring. They typically grow to 10 ft (3 m) in length, and males tend to be a little smaller than females. Little is known regarding their life history traits, but maturity is assumed when the animal reaches 8.5 to 9.2 ft (2.6 to 2.8 m) in length. They tend to travel in groups, which may consist of related animals. Their main diet is squid, but they may feed on a variety of fish species (Ellis, 1982; Klinowska, 1991).

Risso's dolphin generally has an oceanic range, and occurs along the Atlantic coast of North America from Florida to eastern Newfoundland. Risso's dolphins are distributed along the continental shelf edge of the U.S. east shore from Cape Hatteras northward to Georges Bank during the spring, summer and autumn (Waring et al., 2007). In winter, their range begins at the Mid-Atlantic bight and extends further into oceanic waters. In general, the population occupies the mid-Atlantic continental shelf edge year-round, and is rarely seen in the Gulf of Maine (Waring et al., 2007).

Risso's dolphins is protected under the MMPA, but are not considered as strategic stocks (Waring et al., 2007). The best available estimate of Risso's dolphins, from Maryland to the Bay of Fundy, is 15,053 individuals, while the best available estimate for the entire eastern coast is 20,479 individuals (Waring et al., 2007). Given their distribution range, it is possible that Risso's dolphins may occur in Nantucket Sound.

During the period of 2001 through 2005 the total annual estimated average fishery-related mortality or serious injury was three Risso's dolphins (Waring et al., 2007). Incidental bycatch has been observed in the pelagic drift gillnet fishery, and the pelagic longline fishery both in and out of the Northeast Distant water (Waring et al., 2007). From 2001 to 2005, 65 Risso's dolphin strandings were reported, 18 of which were reported in Massachusetts (Waring et al., 2007). During the period of September 2005 to August 2006, the Cape Cod Stranding Network (CCSN) reported approximately 5 Risso's dolphin strandings on the shores of Cape Cod and on the south coast of Massachusetts, with the major cause attributed to entanglement in marine debris and boat strike (CCSN Annual Report, 2006).

**Kogia species (*Kogia sima and K. breviceps*)**

The dwarf sperm whale (*Kogia sima*) and the pygmy sperm whale (*K. breviceps*) are distributed worldwide in temperate to tropical waters. They are very difficult to distinguish at sea, and are often categorized as *Kogia sp*., as in this report. Sightings of *Kogia sp.* occur in all oceanic waters, including the North Atlantic (Waring et al., 2007). They are stocky animals, reaching average lengths of 10 ft (3 m) and typically have grayish coloring. Males mature at 9 to 10 ft (2.7 to 3 m) while females mature at 8 to 9 ft (2.6 to 2.7 m). They typically form small groups, and are slow swimmers. Their diet consists of mainly squid and octopus, but may also include crab, fish, and shrimp (Katona 1993; Leatherwood and Reeves, 1983).

Both of the *Kogia sp*. are protected under the MMPA, and neither are considered a strategic stock in the Western North Atlantic (Waring et al., 2007). The best estimate for *Kogia sp*. from northern Western Atlantic is 358 individuals, while the entire U.S. Atlantic surveys showed 935 individuals (Waring et al., 2006).

During 2001 and 2005 the total annual estimated average fishery-related mortality and serious injury to the dwarf sperm whale and pygmy sperm whale were zero (Waring et al., 2007). Incidental bycatch has been observed in the pelagic longline fishery. From 2001 to 2005 there were 30 reported strandings of the dwarf sperm whale, only 1 of which occurred in waters of Massachusetts (Waring et al., 2007). There were 51 strandings reported of pygmy sperm whales from Maine to Puerto Rico, only 1 of which occurred in waters of Massachusetts (Waring et al., 2007). In addition, there were 11 strandings documented as *Kogia sp.* during the period of 2001-2005 (Waring et al., 2007). During the period of September 2005 to August 2006, the Cape Cod Stranding Network (CCSN) reported approximately 1 pygmy sperm whale stranding on the shores of Cape Cod and on the south coast of Massachusetts, with the major cause attributed to entanglement in marine debris and boat strike (CCSN Annual Report, 2006).

### 4.2.7 Fish and Fisheries

In the Nantucket Sound area, managing or monitoring of fishery resources is conducted by both Federal and state agencies. NOAA Fisheries manages recreational and commercial fishing activities in coastal states in the United States. The New England Fisheries Management Council (NEFMC) and the Mid-Atlantic Fishery Management Council (MAFMC), established by the Magnuson-Stevens Act, manage various fishery resources within the Federal fishery conservation zone in the Nantucket Sound area. The Atlantic States Marine Fisheries Council coordinates the management actions of many coastal states for species that occur in near-coastal waters, including striped bass, American lobster, and others. The Commonwealth of Massachusetts monitors fishery resources in its coastal waters mainly through the activities of MassDMF.

The following section describes existing fisheries resources that occur within the area of the proposed action. Information was obtained from agency monitoring programs, consultations, literature reviews, and site investigations. While shellfish are considered under fisheries because of their linkage with commercial and recreational harvesting of seafood, their life histories, habitat occurrences, and potential impacts are closely aligned with benthic species habitats and are discussed also in Section 4.2.5.

### 4.2.7.1 Demersal and Pelagic Fish

This section presents a description of fish species including expected seasonal occurrence in Nantucket Sound and the area of the proposed action. Review of the scientific literature indicates that few studies related to fishery resources have been conducted specifically in the proposed action locale in Nantucket Sound and Lewis Bay. Data available from studies conducted by NOAA Fisheries, MassDMF, and others were reviewed and evaluated regarding their applicability to the proposed action.

NOAA Fisheries collects data that are "fishery independent" with a bi-annual bottom research trawl survey program; however, the surveys occur offshore of Nantucket Sound and are therefore not useful in characterizing the fishery resources for the area of the proposed action. (As described below, however, MassDMF conducts research trawl surveys in waters under state jurisdiction, including Nantucket Sound, and these surveys are integrated with the NOAA Fisheries bottom research trawl survey database.) In addition, NOAA Fisheries collects information on commercial fish catches, as defined by discrete statistical reporting zones. NOAA Fisheries also identifies and designates EFH for marine species in the United States as part of their responsibility to manage the fish resources of coastal waters. In the Northeast region, NOAA Fisheries works with the New England Fishery Management Council (NEFMC) and also the Mid-Atlantic Fishery Management Council (MAFMC) in defining essential fish habitat for key species that occur in the coastal New England waters, including Nantucket Sound. Detailed source documents were used to describe life history stages for each species and habitat that is necessary for survival of each life history stage. The source documents also provide information on ecology, basic biology, and species behavior such as spawning, migratory behavior and food preference. This information was used with literature and field data collected by the applicant in preparing the EFH Assessment that is found in Appendix H of this document.

MassDMF is involved in studying the basic biology and ecology of anadromous fish species, tautog, northern shrimp, lobster, and recreational fish species, including big game species, sharks, bluefin tuna, and striped bass in state waters. MassDMF performs bi-annual research trawl surveys for the collection of fishery-independent information related to the distribution and abundance of fish and invertebrates in Massachusetts' waters (including both state and Federal waters in Nantucket Sound). These trawl surveys have been on-going in May (spring) and September (fall) each year since 1978. The results of the trawl surveys are compiled with the results of offshore NOAA Fisheries research trawl surveys. State and federal research trawl data is analyzed to understand population structure, stock status, and the geographic distribution of fish and shellfish along the Eastern Seaboard of the United States.

The MassDMF research trawl survey dataset was used to provide an overview of the occurrence of fishery resources in the area of the proposed action, including the identity of species and their frequencies of occurrence in research trawls during a 30-year period. The research trawl program was not designed for the statistical testing of similarities or differences in fish abundance or distribution between specific sites, however. Further, survey timing does not permit the surveys to adequately represent fish distribution and abundance over an entire year. Survey timing coincides with the seasons when juveniles or adults are present in inshore areas. The survey's gear type (otter trawl) and methods are more effective for collecting semi-pelagic and demersal fish species; thus, analyses evaluating species occurrence may not represent accurate distribution and abundance for pelagic species.

Research trawl data during 1978 to 2007 were obtained from MassDMF for all of Nantucket Sound. In Nantucket Sound, trawl data typically is collected for 10 randomly sampled tows for "strata 15" (0 to 30 foot depths) and 11 randomly sampled tows for "strata 16" (31 to 60 foot depths). Data fields include species, pounds, and catch number. Size composition data were not requested. Both juvenile and adult lifestages are collected using this method.

This analysis provides information for a general assessment of species occurring in Nantucket Sound and on Horseshoe Shoal in the months of May and September based on data collected over a period of 30 years. The actual number of randomly sampled tows varies from year to year depending upon weather conditions and other factors, so it is not straightforward to use measures of weight or catch number as an index of catch per unit effort. After correcting for factors affecting research trawl effort, estimates of catch per unit effort from 1990 through 2002 were calculated for the site of the proposed action at Horseshoe Shoal (Report No. 4.2.7-1).

Between 1978 and 2007, 120 species were recorded in the bi-annual resource trawl data set for Nantucket Sound. Over the 27-year period, surveys conducted in the spring collected 74 species, and surveys conducted in the fall collected 103 species. For each species sampled in both the fall and the spring, fall catch numbers tend to be higher than spring catch numbers (see the individual entries in Tables 4.2.7-1 and 4.2.7-2). For each species sampled in both the fall and the spring, fall catch weights tend to be lower than spring catch weight numbers (see the individual entries in Tables 4.2.7-3 and 4.2.7-4).

Nantucket Sound supports a diverse fish community. Off the east coast of Cape Cod, a temperature gradient forms during summer months, setting a boundary so that colder water fish occur to the north and warmer water fish occur to the south (Freeman and Walford, 1974). This temperature gradient fluctuates north and south over an area of 20 to 40 miles (32 to 64 km) along the Cape Cod shoreline. Due to the presence of the temperature gradient along Cape Cod and its geographic location, Nantucket Sound serves as a migratory pathway for some warm-water species as they move into Cape Cod Bay and Massachusetts Bay. The Nantucket Sound area also is a northern border for some summer migrant species, including black sea bass, northern fluke, and scup.

Some fish species that have been observed in Nantucket Sound exhibit migratory behavior and are known to move in and out of areas when there are changes in water temperature. In winter and early spring, some fish species are known to concentrate on shoal areas in Nantucket Sound for spawning or feeding, and some move from the shoal areas to deeper water or channel areas. The winter flounder is a species that is known to move from shoal areas to deeper water and channel areas in summer months when shallower water in the shoal areas has warmer water temperatures. In fall, when the water temperatures start to cool, winter flounder are known to move back to shoal areas. Thus, in spring when water temperatures are cool, winter flounder are likely to be more common than in September when water temperatures remain warmer.

Tables 4.2.7-5 and 4.2.7-6 present for each species the percent occurrence, mean weight (pounds) per tow, mean numbers of fish per tow, and the number of annual cruises (maximum of 30) in which a species was observed. The species are arranged in descending order by percent occurrence. (Percent occurrence is defined as the proportion of all tows during the 30-year period in which a particular species is observed.) As observed in the fall tows (Table 4.2.7-5), longfin squid, scup, butterfish, black sea bass, spider crab, smooth dogfish, lady crab, northern searobin, summer flounder, little skate, and knobbed whelk exhibit the highest percent occurrences (above 50 percent), mean numbers per tow, and weights per tow. Bay and striped anchovies also exhibit high numbers per tow. As observed in the spring tows (Table 4.2.7-6), longfin squid, spider crab, winter flounder, windowpane flounder, little skate, Atlantic rock crab, Northern searobin, winter skate, summer flounder, channeled whelk, Atlantic cod, and knobbed whelk exhibit the highest percent occurrences (above 50 percent), mean numbers per tow, and weights per tow. Scup, butterfish, and Atlantic herring also exhibit high numbers per tow.

### 4.2.7.2 Commercial and Recreational Fish and Shellfish

Review of the scientific literature indicates that few studies related to commercial and recreational fishery resources have been conducted specifically at the proposed action locale in Nantucket Sound. Data on commercial fishing are available from monitoring conducted by NOAA Fisheries and MassDMF. Data on recreational fishing is available from surveys and monitoring conducted by NOAA Fisheries. Examination of these survey and monitoring data help to understand the scale, species mix, and geographic distribution of commercial and recreational fishing in Nantucket Sound. The data are not fully descriptive of all commercial and recreational fishing activity, however, as some fisheries are not monitored, either in whole or in part. Further, there are overlaps in the monitoring efforts conducted by NOAA Fisheries and MassDMF. Recent changes in data collection implemented by MassDMF using both fishermen's catch reports (striped bass and fluke) and an electronic dealer reporting system (shellfish) are likely to resolve some of these overlaps and data gaps. These changes provide information for only two years, however. This section presents an assessment of the best available data on commercial and recreational fisheries for Nantucket Sound.

Additional information about commercial and recreational fishing in Nantucket Sound has been produced by the project proponent and stakeholders. Two independent surveys were sponsored by the project proponent to obtain additional information about commercial and recreational fishing activities in Nantucket Sound. The sample sizes and sample selection processes limit the statistical significance of the conclusions of these surveys. Nevertheless, these surveys yield useful, albeit anecdotal, information on target species, fishing locations, and the seasonality of fishing in Nantucket Sound. Additional information provided through a study of the commercial squid and fluke fishery sponsored by the Massachusetts Fishermen's Partnership also is reviewed, and its conclusions are critiqued.

Report No. 4.2.7-2 provides life history descriptions for additional species occurring in Nantucket Sound that have not been addressed in the EFH Assessment (Section 4.2.8). These species include 22 species (including the horseshoe crab) managed by the Atlantic States Marine Fisheries Commission (ASMFC); other commercially or recreationally important species; and forage species. The other commercially or recreationally important species were identified from reviews of MassDMF Nantucket Sound commercial catch data, NOAA Fisheries commercial vessel trip report (VTR) data pertaining to Nantucket Sound, NOAA Fisheries charter and party boat (CPB) VTR data pertaining to Nantucket Sound, and the results of the recreational intercept surveys and interviews sponsored by the project proponent (mentioned above). Report No. 4.2.7-2 provides summary information including life history descriptions on the prey of EFH species, ASMFC managed species, and additional commercial and recreational fish species.

#### 4.2.7.2.1 Commercial Fisheries

Nantucket Sound supports commercial fisheries for diverse species of fish and invertebrates such as squid, conch, quahogs, fluke, black sea bass, bluefish, striped bass, Atlantic mackerel, and lobster. Both Federal and State agencies monitor certain commercial fishing activities in Nantucket Sound. NOAA Fisheries monitors federally-permitted commercial fishing activities in the northeast United States, including fishing activity in Massachusetts and specifically in Nantucket Sound. The Commonwealth of Massachusetts monitors state-permitted commercial fishing activities for certain fisheries and gear types in its coastal waters. NOAA Fisheries also collects price information for fisheries that are federally-permitted on a county-wide basis through a dealer database. Information from these programs has been used to describe the commercial fisheries in Nantucket Sound.

NOAA Fisheries and MassDMF collect both independent and overlapping data. Mechanisms for collecting the data vary. NOAA Fisheries compiles trip-based reports to monitor catches, species types, gear types, and fishing locations for Federal permit holders only. MassDMF compiles data through both a dealer reporting system, called the Standard Atlantic Fisheries Information System (SAFIS), and commercial fisherman reporting for certain gears (fish pots, fish weirs, and gillnets) and for certain quota-managed fisheries. In addition, municipalities report shellfish catches and production from shellfish leases on tidelands and state submerged lands.

In order to understand the gaps and overlaps in the monitoring of commercial fisheries in Nantucket Sound, it is critical first to understand how the state-level monitoring system works. MassDMF compiles data on finfish and shellfish catches from fishermen's catch reports, seafood dealer reports, and municipal shellfish reports. Fishermen file catch reports with MassDMF on an annual basis, identifying the species caught, catch levels, and, in the case of shellfish, the location of harvest. The reporting of shellfish harvest location is required for public health purposes. Fishermen are not required to identify the location of finfish catches, other than for certain gear types, fish weirs, fish pots, and gillnets, for handline catches and releases of striped bass, and for fluke by MassDMF statistical area (within the last two years). The NOAA Fisheries VTR system requires that fishermen identify the location of both finfish and shellfish harvests. A significant number of state-permitted fishermen do not hold federal permits, however, and this leads to a gap in the collection of data on finfish catches from these vessels. While the overall level of catch is known as fishermen land their catches and sell them to seafood dealers (explained below), it is not feasible to tie the catches to specific locations such as Nantucket Sound.

In order to sell marine species in Massachusetts, a fisherman must have a state permit and, if relevant, any required endorsements (i.e., coastal access permits [CAPs] with endorsements) for quota-managed species. A fisherman may have a federal permit as well. In theory, some fish may be harvested in Nantucket Sound by fishermen with federal permits only or with permits from other states (such as Rhode Island or Maine), but, absent a Massachusetts permit, these fish cannot be landed and sold in Massachusetts. It is thought that the level of catch in Nantucket Sound by non-Massachusetts permit holders is small, but the actual level is unknown.

Beginning in 2005, all "primary buyers" (seafood dealers or fishermen that are also dealers) in Massachusetts are required to report their purchases of marine species from fishermen. These dealers must check to make sure that fishermen hold valid state fishing permits. The dealers report into the SAFIS dealer reporting database, and Massachusetts landings of quota-managed species, including *Loligo* and *Illex* squid, black sea bass, bluefish, striped bass, dogfish, fluke, scup, and tautog, are accounted for through this system. The SAFIS system is used to keep track of the catches in relation to an annual state quota, and any fisheries that exceed the quota are closed.

The Federal VTR reporting system collects data on fishing location, as well as catch weight, gear type used, and species caught. The federal VTR data may overlap the state data for species that are sold in Massachusetts. In general, for finfish catches, it is not feasible to determine the degree of overlap for an area such as Nantucket Sound, because the proportion of annual catches of finfish caught by state permit holders in Nantucket Sound is not recorded. Although the SAFIS system requires that seafood dealers collect both state permit ID and federal VTR numbers, again, there is no requirement to report the geographic location for state permitted finfish catches. In the case of shellfish, the SAFIS system can be used in the future to distinguish between state and federal permitted catches in the designated SAFIS shellfish growing areas.

Because of the incompleteness of the data and the unknown extent of overlap between the state and federal data monitoring systems, it is not possible to completely characterize the scale of commercial fishing for finfish in Nantucket Sound. The data have been arranged into a unified format in tables that allow close comparison between the NOAA Fisheries and MassDMF data. In order to enhance the comparison, catches of certain related species are tabulated together (this matches the MassDMF approach to compiling data). For example, conch includes the knobbed, channeled, and lightning whelks.

Similarly, squid include both *Loligo* and *Illex* squids; dogfish include both the smooth and spiny dogfish. (Technically a mollusk, squid are included in the finfish data because of their physical behavioral characteristics.) The data can be used to identify the types of commercial fishing in Nantucket Sound and the proportions of different fish catches in each dataset. The data are roughly representative of the scale of commercial fishing in Nantucket Sound, subject to the caveat on incompleteness and overlaps discussed above.

NOAA Fisheries and MassDMF commercial fisheries data are presented in the following sections. This discussion is supplemented with additional information from a recent study sponsored by the Massachusetts Fishermen's Partnership and a study sponsored by the project proponent.

**NOAA Fisheries Commercial Fisheries Data**

NOAA Fisheries divides the U.S. coastal ocean into statistical sampling areas. Waters near Cape Cod and the Islands have been designated as NOAA Fisheries Statistical Area 538, and Nantucket Sound is designated as Subarea 075. Fishermen report catches by statistical area or subarea and by specific latitude-longitude (lat-lon) coordinates or LORAN coordinates. (In the tables and figures below, lat-lon coordinates were used to sort the data to identify catches occurring specifically in Nantucket Sound.) Prior to 1994, landings information was collected through a system of voluntary reporting. NOAA Fisheries port agents collected fish landings and price information at the locus of initial sale through dealer reports or "weigh-out receipts." A mandatory reporting system replaced the voluntary weigh-out reporting method in June 1994. The new reporting system requires fishermen to submit vessel trip report (VTR) logbooks that characterize their catches, including the location where the majority of fishing occurred during a specific trip. Seafood dealers report fish received at the point of sale to the SAFIS program. Because the VTR system was initiated in 1994, there are no data from 1990-1993 to compare with MassDMF data, which have been collected since 1990.

Table 4.2.7-7 presents the VTR finfish catches in pounds by species in each year from 1994 through 2007. Table 4.2.7-8 presents the VTR shellfish catches in pounds by species in each year from 1994 through 2007. Catches of the most common species appear to have increased significantly in the VTR database beginning in 1998. This observation may be the result of increased compliance with the VTR system or a shift from offshore fishing grounds to near coastal waters or both. The last ten years of data (1998-2007) are probably most representative for Nantucket Sound.

From 1998 through 2007, based on the VTR data, an average of 762,650 lbs (346,659 kg) of commercial finfish catches and an average of 251,808 pounds (114,458 kg) of commercial shellfish catches were harvested from Nantucket Sound. Finfish catches, which are heavily influenced by squid and fluke, peaked during 2006. Shellfish catches, which are heavily influenced by conch (whelk species), peaked also in 2006. Report No. 4.2.5-5 presents more detailed analyses of commercial fisheries data from 1994 to 2004.

Commercial fishermen use a variety of gear types for harvesting commercial finfish and shellfish species, including otter trawls, dredges, fish weirs, seines, a variety of traps/pots, and hand lines. Federal VTR data reveal that largest catches during 1994 to 2007 were made from otter trawls for squid and groundfish. Table 4.2.7-9 shows the proportion of total finfish catches by gear type in the VTR data for Nantucket Sound during 1998 to 2007. Sixty percent of catches were made with otter trawls for bottom fish. Eighteen percent of catches were made with fish weirs, and 14 percent were made with fish pots.

As measured by average annual catches, the top 10 species of finfish caught in Nantucket Sound by commercial fishermen with federal permits include squid, fluke, Atlantic mackerel, black sea bass, scup, bluefish, menhaden, butterfish, winter flounder, and king whiting (Table 4.2.7-10). Catches of these fish represent 99 percent of average annual total VTR catches during 1998-2007. Catches of squid represent 50 percent of average annual catches. Using average annual price for each species over the ten year period, the average annual gross sales value of these finfish catches are on the order of $800,000. As explained above, a significant, but unknown, amount of finfish are caught by state-permitted fishing vessels in Nantucket Sound. These catches would significantly increase the total gross sales value, but there is currently no way of attributing state-permitted catches to Nantucket Sound (other than for fluke since 2006).

Some insight is gained on the geographic distribution of fish catches by plotting the NOAA Fisheries VTR lat-lon position data. Figures 4.2.7-1 through 4.2.7-3 display the location of finfish catches in Nantucket Sound from 1998 to 2007. Figure 4.2.7-1 depicts total finfish (including squid) catches. Most catches are located around but not inside of the proposed project area. Figure 4.2.7-2 breaks-out squid catches separately. Note the change in scale. Squid catches are located to the north and south of the project area; only a few are located within the area. Figure 4.2.7-3 breaks-out fluke catches separately. These tend to occur to the east and southeast of the project area. It is important to note that there is one location given for each VTR trip, but trips, especially trawls, can occur over a substantial distance, covering large areas. Consequently, it is possible that trawling across Horseshoe Shoal goes unrecorded in the data. This seems unlikely to occur on a consistent basis over a period as long as 1998 to 2007, however.

As measured by average annual catches, the top five species of shellfish caught in Nantucket Sound by commercial fishermen with federal permits include conch, ocean quahog, surf clam, hard clam, and horseshoe crab (Table 4.2.7-11). Catches of these shellfish represent 99 percent of average annual total VTR shellfish catches during 1998-2007. Catches of conch represent 88 percent of average annual catches. Using average annual price for each species over the ten year period, the average annual gross sales value of these shellfish catches are on the order of $646,000.

Table 4.2.7-12 shows the proportion of total shellfish catches by gear type in the VTR data for Nantucket Sound during 1998 to 2007. Seventy-eight percent of total catches were made with conch pots and 21 percent with clam dredges.

Figure 4.2.7-4 displays the location of total shellfish catches in Nantucket Sound from 1998 to 2007. A large number of catches are made just at the bottom of the project area. Most catches are located to the east and southeast of the proposed project area, however.

**MassDMF Commercial Fisheries Data**

MassDMF studies and monitors marine fishery resources that fall under its jurisdiction. This effort includes the commercial harvests of both finfish and shellfish. MassDMF administers several programs to manage marine fishery resources. The Fisheries Dependent Investigation Project involves monitoring the catch and by-catch composition of some of the state's fisheries. The Management Information Systems and Fisheries Statistics Project maintains a commercial database for shellfish, lobster, and other regulated fisheries. MassDMF has divided Massachusetts coastal waters into statistical areas. Nantucket Sound is has been designated Area 10, which is apparently equivalent to the NOAA Fisheries Subarea 075. Commercial fishermen are required to submit catch reports for hook and line (striped bass), fish weirs, gillnets, shellfish (compiled by municipalities), lobster pots, and fish pots (black sea bass, scup, and conch). Report No. 4.2.5-5 presents detailed information regarding these data during 1990-2004.

The state-permitted gillnet fishery does not make up a large component of state-reported catches in Nantucket Sound. From 1990 to 2003, gillnet catches were reported during only five years including 1992, 1993, 1995, 1999, and 2002. Only one commercial gillnet license was issued for the area in 1992, 1995, and 1999. Only three fishermen reported using gillnets in the area in 1993. There were no fishermen reporting the use of gillnets in the remaining years. From 2004 to 2007, however, a gillnet fishery targeting bluefish has yielded significant catches (averaging 24,000 pounds) in Nantucket Sound.

Both scup and black sea bass are important fisheries in Nantucket Sound. Many commercial fishermen have licenses for the harvesting of these species using fish pots. Numbers of fishermen using fish pots for black sea bass in Nantucket Sound varied over the years with a high of 38 in 1991 and a low of 18 in 1998. Black sea bass catches peaked in 2002 at 419,077 pounds and have averaged about 200,000 pounds annually since that year. Reporting of catch for harvesting of scup from fish pots has been required only since 1994. For 1994 there were 49 fishermen fishing pots for scup in MassDMF Area 10. This number decreased to 28 by 2004. This number has declined during the years to a low of 21 fishermen fishing pots for scup in Nantucket Sound. Scup catches are now only about ten percent of the large pot catches in the 1990s.

The striped bass fishery is another important fishery in Nantucket Sound. This species is harvested both commercially and recreationally in Nantucket Sound. The striped bass commercial fishery is a hook and line fishery only with the season going from mid-July until the quota is filled (MassDMF 2005). MassDMF monitors striped bass that are landed and sold to the Nantucket Sound seafood dealers, in addition to those caught and released, or kept by fishermen. The striped bass hook and line fishery has consistently yielded landings of under 100,000 pounds until 2006-2007. In these recent two years, the fishery averaged more than 200,000 pounds (this figure does not include fish that were caught and released). Note that some unknown proportion of striped bass caught in Nantucket Sound may be marketed to seafood dealers outside of the region.

From 1998 through 2007, based on MassDMF data, an average of 1,149,488 pounds (522,495 kg) of commercial finfish catches (including squid) and an average of 1,650,129 pounds (750,059 kg) of commercial shellfish catches were harvested from Nantucket Sound (Tables 4.2.7-13 and 4.2.7-14). Both finfish catches, which are heavily influenced by squid, scup, Atlantic mackerel, black sea bass, and fluke, and shellfish catches, which are heavily influenced by conch (whelk species), peaked in 2006. Report No. 4.2.5-5 presents more detailed analyses of commercial fisheries data from 1994 to 2004.

As measured by average annual catches, the top ten species of finfish caught in Nantucket Sound by commercial fishermen with state permits include black sea bass, Atlantic mackerel, squid, fluke, scup, striped bass, menhaden, bluefish, butterfish, and bonito (Table 4.2.7-10). Catches of these fish represent 99 percent of average annual total MassDMF catches during 1998-2007. Catches of black sea bass represent 20 percent of average annual catches. Using average annual price for each species over the ten year period, the average annual gross sales value of these finfish catches are on the order of $1,710,000.

As measured by average annual catches, the top three species of shellfish caught in Nantucket Sound by commercial fishermen with state permits include conch, hard clam, and lobster (Table 4.2.7-11). Catches of these shellfish represent 99 percent of average annual total MassDMF catches during 1998-2007. Catches of conch represent 72 percent of average annual catches. Using average annual price for each species over the ten year period, the average annual gross sales value of these shellfish catches are on the order of $6,200,000.

During 2006-2007, the SAFIS database records landings from Designated Shellfish Growing Areas (DSGAs) in Nantucket Sound. Figure 4.2.7-5 shows that the majority of Horseshoe Shoal lies within Area NS-4. This database is believed to be comprehensive for shellfish, but it comprises only two years of landings thus far. Table 4.2.7-15 presents the SAFIS shellfish landings during this period and the two-year average. Average annual landings of all shellfish equal 16,543,299 pounds. Of the four DSGAs in Nantucket Sound, Area NS-4 produces the lowest amounts (only whelk are produced in that area). Table 4.2.7-16 presents the leading shellfish products in order of average pounds landed. Again, reaffirming the other databases, the leading shellfish is conch, comprising 77 percent of total landings. Using average annual price for each species over the two year period, the average annual gross sales value of these shellfish catches are on the order of $50,226,000. This is the best estimate of shellfish production and value in Nantucket Sound.

Table 4.2.7-17 shows the proportion of total finfish catches by gear type in the MassDMF data for Nantucket Sound during 1998 to 2007. (Striped bass data represent landings reported by Nantucket Sound seafood dealers.) Fifty-nine percent of catches and landings were made with fish weirs and 27 percent with fish pots. Again, there has been no reporting for finfish, other than fluke during 2006 to 2007, specifically for Nantucket Sound. Table 4.2.7-18 shows the proportion of total shellfish landings by gear type in the MassDMF data for Nantucket Sound during 1998 to 2007. Seventy-five percent of total catches were made with conch pots and 22 percent with clam dredges.

**Massachusetts Fishermen's Partnership Study**

In an unpublished study sponsored by the Massachusetts Fishermen's Partnership, Wiersma (2008) examines the potential economic impacts of the construction and operation of the WTGs on the squid and fluke fisheries in Nantucket Sound. The author notes the lack of data on catches of vessels holding Massachusetts coastal access permits (CAPs) with endorsements for squid and fluke. Although the state data are incomplete, the author finds that two-thirds of squid and fluke CAP holders also hold federal permits. The catch and location of catch for these vessels is accounted for in the NOAA Fisheries VTR database. The author suggests that "VTR data can provide a general idea of mobile gear landings" for squid and fluke.

The author provides important details about the characteristics of the squid and fluke fisheries in Nantucket Sound. The average size of small mesh squid season otter trawlers is 50 feet (in order to obtain a squid endorsement, these vessels cannot exceed 72 feet). Fishermen who hold CAP endorsements for squid and fluke fish for squid mainly from April to June and for fluke mainly from July through September. These vessels are able to switch gear (to comply with mesh size regulations) readily in order to prosecute both fisheries. Massachusetts CAP permits with endorsements for squid and fluke are held by fishermen from Massachusetts, Rhode Island, New Hampshire, and Maine. Massachusetts CAP holders fish Nantucket Sound the most frequently, followed by vessels from Rhode Island. Many vessels from Rhode Island, New Hampshire, and Maine are limited in their use of CAP endorsements because of the distances required to travel to Nantucket Sound.

Citing a study conducted by scientists at MassDMF (McKiernan and Pierce, 1995), the author finds that nearly all squid taken in Massachusetts waters are from Martha's Vineyard Sound and Nantucket Sound. Further, Nantucket Sound near Horseshoe Shoal is the second-most trawled area for squid. Citing a presentation by another MassDMF scientist (Malkowski, 2001), the author reports that, in the 2000 fishing season, 34 trawlers landed 637,522 pounds of squid and 58 trawlers landed 508,785 pounds of fluke in Nantucket Sound. Based on a survey of fishermen (discussed below), the author finds it likely that many of these vessels were fishing around Horseshoe Shoal.

The author realizes that navigation of Horseshoe Shoal by fishing vessels may not be regulated or constrained even after the construction of the WTGs. Even in the absence of regulation, the author identifies a number of potential external effects ("social costs") of the construction and operation of the WTGs on Horseshoe Shoal. These potential effects comprise increased steaming time; heightened risks of collisions; loss of access to traditional tow patterns; reductions in the number of tows; reductions in days fished; and increased transactions costs.

The author surveys a sample of the squid and fluke endorsement CAP holders (it is unclear from the study whether the sample is random or not). The author finds that 34 fishermen (out of 48 who were contacted) fish in the Horseshoe Shoal area for squid and fluke. (This number is the same as that identified in 2000 by MassDMF (Malkowski, 2001). During the survey, it is discovered that only 22 out of the 34 fishermen use their permits in Nantucket Sound. (In questions to respondents the author estimates that between 30 to 50 Massachusetts vessels and between 15 to 20 out-of-state vessels use Nantucket Sound. The frequency of use by these vessels is not further characterized.)

The survey is used to develop estimates of the proportion of total fishing income that can be attributed to fishing in the Horseshoe Shoal area. Further, respondents are asked to characterize what they would accept for compensation (willingness to accept a lawsuit settlement) if either (i) they become excluded from Horseshoe Shoal or (ii) they are not excluded but inconvenienced by the construction and operation of WTGs on Horseshoe Shoal.

Per fisherman, the author finds a mean fishing income in the area of Horseshoe Shoal of $14,590, and willingness to accept compensation for exclusion of $31,471 or inconvenience of $19,370. The difference between income loss and willingness to accept compensation are attributed to a fisherman's "satisfaction bonus," or the amount required to leave fishing and assume another occupation. Assuming that the average number of vessels prosecuting the fishery is 45, the author estimates a net present value over 25 years (using a discount rate of 10 percent) of $6 million for mean fishing income in the area of Horseshoe Shoal, and willingness to accept compensation for exclusion of $13 million or inconvenience of $8 million. The $8-13 million range was widely cited, without elaboration of the underlying assumptions or methodologies, by commenters on the DEIS.

The Wiersma (2008) analysis brings a focus to two of the leading fisheries in Nantucket Sound. It's conclusions must be tempered, however, by several points. First, there has been no suggestion that Horseshoe Shoal will be closed to fishing. If it is not closed, the upper bound of $13 million is not relevant. Second, it is not clear that the social costs identified by the author are actual and not potential costs. The incidence of these costs cannot be demonstrated conclusively in the absence of the construction and operation of the WTGs. Even if the social costs are actual, it is unclear that fishermen would require a satisfaction bonus. The distribution of squid and fluke fishing activity in the VTR database (Figures 4.2.7-2 and 4.2.7-3), which, according to the author, provides a general idea of mobile gear landings, indicates that this fishing activity rarely occurs on Horseshoe Shoal proper. It is reasonable to assume that squid fishermen will continue to fish unhindered in Nantucket Sound mainly to the east of and along the margins of Horseshoe Shoal and mainly to the east of and southeast of Horseshoe Shoal (off Nantucket) for fluke. If this is true, then the difference between mean income on Horseshoe Shoal and the lower bound of $2 million ($8m - $6m = $2m) required for a satisfaction bonus is not relevant.

Given their historical use of the area, fishermen might be compensated on the basis of equity (fairness) if there would be losses to income. Precedents for such a policy may be found in the cases of the siting of deepwater ports for liquefied natural gas established recently off Boston. Absent data on the number of CAP holders fishing on Horseshoe Shoal, it is unclear what should be the level of aggregate mean lost income. If there is only limited fishing occurring on Horseshoe Shoal, as suggested by the VTR data, then the economic impact may be insignificant. Whether there will be impacts or not is an empirical question that cannot be answered without knowing the actual extent of commercial finfish harvesting that occurs within the proposed project area. Answering this question is made problematic by the gaps in data collection for state-permitted vessels fishing for finfish that have been described in the previous sections.

An important finding of this study is that between 40 and 50 vessels were unaccounted for in the FEIR or the DEIS. This suggests that there is a need for the Commonwealth of Massachusetts to begin the compilation of data on the location of fishing activity in Nantucket Sound. With such data available, the MassDMF proposal for post construction analysis of the effects of the construction and operation of the WTGs becomes much more viable, because it would enable the comparison of fishing activity with and without the construction of the wind power facility.

**Survey of Commercial and Recreational Fishing Activities – 2005**

In 2005, a survey of recreational and commercial fishermen, shellfish officers, harbor masters, bait and tackle shop employees, and a commercial fish dealer was sponsored by the project proponent. Several commercial fishermen and one fish dealer were contacted by mail and were asked to participate voluntarily in the survey. Some of the respondents were interviewed in person, but most were interviewed by phone in the late summer and early fall of 2005. Information on categories and numbers of respondents, selection methodologies, survey methodologies, and summary information on the respondents is presented in detail in the *Survey of Commercial and Recreational Fishing Activities* (Report No. 4.2.5-6).

In the overall survey group, there were 18 commercial and fixed gear fishermen who averaged 32 years of commercial fishing (Report No. 4.2.5-6). This is a small group of respondents, and the selection process for the survey cannot be described as random. Nevertheless, the results of the survey are reported here as information useful for a description of the types of fishing activities in Nantucket Sound and specifically on Horseshoe Shoal.

A summary of the survey selection methodology for the commercial and fixed gear fisherman is presented here. To select the fishermen, license and address information for commercial fishermen who reported landings in Nantucket Sound on federal vessel trip reports (VTRs) or state catch reports was obtained from MassDMF. This database included a list of 399 state- or federally-licensed vessels. Federally-licensed vessel information provided by MassDMF included vessels that both reported landings from NMFS Area 075 (Nantucket Sound) on a VTR from 2000 to 2004 and for which there was matching contact information in the MassDMF database. State licensed vessel information included those vessels that reported landings in MassDMF Area 10 (Nantucket Sound) on a Massachusetts catch report from 2000 to 2004. The commercial vessel license database provided by MassDMF included 82 federally-licensed fishermen and 332 state-licensed fishermen. Fifteen fishermen reported landings from Nantucket Sound via federal VTRs and state catch reports and 317 fishermen reported Nantucket Sound landings via state catch reports only.

Based on discussions with NOAA Fisheries and MassDMF staff, survey letter requests were sent to 50 of the identified fishermen in hopes of receiving at least 12 responses. The method for selecting fishermen to receive a survey letter was deemed acceptable by MassDMF staff. A survey request letter was sent also to one commercial fish dealer on Cape Cod at the request of the USACE. Of the 50 commercial fishermen contacted, 21 replied by mail. Nineteen of the 21 offered to participate in the survey and two declined. Every effort was made to include those who wished to participate. A total of 18 respondents were reached and surveyed by phone.

The 18 surveyed commercial fishermen reported that their boats fished in Nantucket Sound for the following species, which are presented in order of diminishing frequency: scup, squid, and fluke (summer flounder), sea bass, conch, tautog, stripers, and bluefish.

Commercial mobile gear fishermen reported that squid is an important fishery in Nantucket Sound in the spring. Trawlers harvest this species. Twelve of 13 trawlers in the sample survey of 21 boats (57 percent) fish for squid in April and May. Ten boats were active in June. Areas heavily fished included nearshore Falmouth to Hyannis to Horseshoe Shoal and Half Moon/Cross Rip Shoals. Out of 12 commercial trawlers targeting squid that were surveyed, approximately 27 percent reported fishing in the Horseshoe Shoal area and 73 percent reported fishing outside of the Horseshoe Shoal area.

Of 21 boats owned or managed by surveyed commercial fishermen, 11 (52 percent) trawled for fluke with mobile gear some time during the season in Nantucket Sound. Active areas for fluke targeted by trawlers included Horseshoe Shoal and Half Moon/Cross Rip Shoals. Medium activity was reported for these areas from April through September. In fall, activity for fluke, especially hook and line fishermen, was reported in Eastern Sound. Of 11 surveyed commercial trawlers targeting fluke, approximately 24 percent reported fishing in the Horseshoe Shoal area and 76 percent reported fishing outside the Horseshoe Shoal area.

In Nantucket Sound, scup fishing with mobile gear was reported to have two active periods. The first was in April through June reported in the nearshore Falmouth to Hyannis, Horseshoe Shoal and Half Moon/Cross Rip Shoals areas. The second was in the fall reported in Tuckernuck Shoals followed by Horseshoe Shoal and Big Flat. Eight of 21 boats (38 percent) under management of surveyed respondents were noted as trawling for scup using mobile gear some time during the season in Nantucket Sound. Of the eight surveyed commercial trawlers that were targeting scup, approximately 28 percent reported fishing in the Horseshoe Shoal area and 72 percent reported fishing outside the Horseshoe Shoal area.

For sea bass the most active fishing was reported to occur in May to June in the Horseshoe Shoal and Half Moon/Cross Rip Shoals areas. In July and August activity diminished but then increased in these areas during September through November. Of the 21 boats owned or managed by the surveyed commercial fishermen, 4 (19 percent) trawl for sea bass some time during the year in Nantucket Sound. Of these 4 surveyed commercial trawlers that target sea bass, approximately 41 percent reported fishing in and 59 percent reported fishing outside the Horseshoe Shoal locale.

Conch fishing was reported to have medium activity levels in summer across much of Nantucket Sound. Areas where medium activity occurred included Horseshoe Shoal, Half Moon/Cross Rip Shoals, Tuckernuck Shoals, and Eastern Sound. Of the 21 boats in the survey sample, two trawlers reported harvesting conch in the Nantucket Sound area. Of the 2 surveyed commercial trawlers that targeted conch, approximately 19 percent reported fishing in and 81 percent reported fishing outside the Horseshoe Shoal locale.

Hook and line commercial fishermen reported fishing activity information. Three of 21 boats (14 percent) fish with hook and line in the Nantucket Sound area some time during the season. Fish species that are targeted include bluefish, fluke, scup, sea bass, striped bass, and tautog. Bluefish were caught by one such fisherman from May to July in various areas of Nantucket Sound including Horseshoe Shoal. Approximately 17 percent of his fishing reported was in the Horseshoe Shoal locale and approximately 83 percent occurred outside the Horseshoe Shoal locale. Two such fishermen caught striped bass. One reported fishing just in July in the Eastern Sound area and the other targeted bluefish and tautog concurrently.

Out of the two commercial hook and line boats that were surveyed, approximately 12.5 percent of reported fishing for striped bass took place in the Horseshoe Shoal locale and approximately 87.5 percent took place outside the Horseshoe Shoal locale. Two of 21 boats owned/managed by surveyed commercial fishermen reported fishing for tautog in Nantucket Sound using hook and line. These fishermen fished commercially for tautog in April to May and in September to October. Of these boats, approximately 30 percent of reported fishing occurred in the Horseshoe Shoal locale and approximately 70 percent occurred outside the Horseshoe Shoal locale. Of three commercial hook and line boats surveyed that targeted scup and fluke, approximately 22 percent of scup fishing and 14 percent of fluke fishing was reported to take place in the Horseshoe Shoal locale. The rest of the fishing effort was reported taking place outside the

Horseshoe Shoal locale. For commercial sea bass fishing using hook and line, Eastern Sound was noted as the most active area during the season. Of three commercial hook and line boats surveyed, approximately 20 percent of sea bass fishing occurred in the Horseshoe Shoal locale and 80 percent occurred outside the Horseshoe Shoal locale.

Commercial fixed gear fishermen reported that most active areas for scup were in the areas that include nearshore Falmouth to Hyannis and Horseshoe Shoal in April and May. Central and eastern Sound areas had medium activity levels in the remainder of the season. Activity levels for sea bass by trap and pot fisherman were the same as those described for scup. Three of 21 boats owned/managed by the commercial fishermen who were surveyed target scup and sea bass with the use of pots and traps. Of the surveyed boats, approximately 27 percent of fishing was noted to occur in the Horseshoe Shoal locale and approximately 73 percent of fishing was noted to occur outside the Horseshoe Shoal locale.

Conch was reported as caught in pots and traps at varying depths in Nantucket Sound. Information about boats targeting conch indicated that Horseshoe Shoal has most activity during the spring through June and in December. In summer, Big Flat and Eastern Sound were reported to have the most conch fishing. Two of 21 boats owned/managed by the commercial fishermen who were surveyed fish for conch with the use of pots and traps. Of these two boats, approximately 27 percent of fishing was noted to take place in the Horseshoe Shoal locale and approximately 73 percent of fishing was noted to occur outside the Horseshoe Shoal locale.

For tautog, the fixed gear boat was reported as most active in April and May in the Horseshoe Shoal and nearshore Falmouth to Hyannis areas. Central and eastern Sound areas had medium activity levels in the remainder of the season. The one boat that targets tautog with pots/traps noted that approximately 31 percent of the tautog fishing took place in the Horseshoe Shoal locale with approximately 69 percent taking place outside the Horseshoe Shoal locale.

Bluefish are commercially caught by one fixed gear gill-netter in Nantucket Sound. It was reported that only bluefish were fished for on Horseshoe Shoal from May through July employing this method (see Report No. 4.2.5-6).

**Horseshoe Crab Fishery Information**

Along the U.S. Atlantic coast, horseshoe crabs are most abundant between Virginia and New Jersey (ASMFC, 2005). This species is common on the shores of Cape Cod as evidenced by one study that tagged over 7,800 horseshoe crabs on Cape Cod between 2000 and 2002 (Pirri et al., 2005). On the shores of Nantucket Sound, they have been observed in Barnstable Harbor (O'Connell et al., 2003) and Monomoy Islands (Pirri et al., 2005; USFWS, 2005a). They are also are observed in Nantucket Sound on a regular basis (ERDG, 2005).

Horseshoe crabs are collected mainly for use as bait in conch and eel pots (Fraser, 2008). Live animals also are collected for research purposes and are returned to the water and not counted towards the state's quota (Fraser, 2008). Massachusetts landings have increased in the past few years leading to a recently reduced number of this species that can be harvested each year to 165,000 (ASMFC, 2008; Daley, 2008). Adults of this species are exclusively subtidal except during spawning; however, their specific habitat requirements are unknown (ASMFC, 1998). Since this species occurs in Barnstable Harbor, there is also a good chance that horseshoe crabs may occur within Lewis Bay in the nearshore proposed action area.

Spring and fall trawl survey data from the Massachusetts MassDMF indicates that horseshoe crabs are present in Nantucket Sound in greater numbers in the fall than in the spring (MDMF, 2005a). In

Massachusetts, studies have been conducted on isolated spawning populations of this species; however there has not been a comprehensive study conducted (Daley, 2008).

**Commercial Fisheries Summary**

Nantucket Sound supports commercial fisheries for many species of fish and shellfish. NOAA Fisheries and MassDMF monitor commercial fishing activities in the Sound, but they collect both independent and overlapping data. A critical gap in data collection is that the annual catches of finfish caught by state permit holders in Nantucket Sound are not tied specifically to Nantucket Sound. (In the last two years, however, catches of fluke only have been monitored and accounted for in Nantucket Sound.) Because of the incompleteness of the data and the unknown extent of overlap between the state and federal data monitoring systems, it is not possible to fully characterize the scale of commercial fishing in Nantucket Sound. The best available data from both federal and state sources must be reported separately, and it can be used only to get a sense of the commercial fish species and their approximate scales relative to catches of other species as reported within each catch monitoring system. Recently MassDMF landings data for shellfish have been linked to designated shellfish growing areas in Nantucket Sound. Further, MassDMF is now keeping track of fluke landings for Area 10.

As measured by average annual catches of vessels holding federal permits, the top 10 species of finfish caught in Nantucket Sound include squid, fluke, Atlantic mackerel, black sea bass, scup, bluefish, menhaden, butterfish, winter flounder, and king whiting. These catches occur primarily in otter trawls, but other gears are used as well. Catches of squid represent 50 percent of average annual catches. Using average annual price for each species over the ten year period, the average annual gross sales value of federally-reported finfish catches are on the order of $800,000. As measured by average annual catches, the top five species of shellfish caught in Nantucket Sound by commercial fishermen with federal permits include conch, ocean quahog, surf clam, hard clam, and horseshoe crab. Catches of conch represent 88 percent of average annual catches. Using average annual price for each species over the ten year period, the average annual gross sales value of federally-reported shellfish catches are on the order of $646,000.

As measured by average annual catches, the top ten species of finfish caught in Nantucket Sound by commercial fishermen with state permits include black sea bass, Atlantic mackerel, squid, fluke, scup, striped bass, menhaden, bluefish, butterfish, and bonito. These catches occur primarily in fish weirs, fish pots, and gillnets. Catches of black sea bass represent 20 percent of average annual catches. Using average annual price for each species over the ten year period, the average annual gross sales value of state reported finfish catches are on the order of $1,710,000. As measured by average annual landings in the SAFIS database, the top five species of shellfish caught in Nantucket Sound by commercial fishermen with state permits include conch, hard clam, horseshoe crab, sea clams, and bay scallops. Catches of conch represent 77 percent of average annual catches. Using average annual price for each species over a two year period, the average annual gross sales value of state reported shellfish catches is on the order of $50 million.

The geographic distribution of fish catches using the federal VTR data show that most catches are located around but not inside of the proposed project area. Squid catches are located to the north and south of the project area. Fluke catches tend to occur to the east and southeast of the project area. Shellfish catches occur primarily in DSGAs to the east and south of Horseshoe Shoal.

A study sponsored by the Massachusetts Fishermen's Partnership examines the potential economic impacts of the construction and operation of the WTGs on the squid and fluke fisheries in Nantucket Sound. The study reaffirms the lack of data on catches of vessels holding Massachusetts coastal access permits (CAPs) with endorsements for squid and fluke. This finding suggests that there is a need for

Massachusetts to compile data on the location of all fishing activity in Nantucket Sound. With such data, analysis of the effects of the construction and operation of the WTGs becomes possible.

### 4.2.7.2.2 Recreational Fisheries

Nantucket Sound is located near several world class vacation destinations (i.e., Cape Cod, Nantucket, and Martha's Vineyard). These areas offer numerous opportunities for recreational fishing. Review of the scientific literature indicates that few studies related to recreational fishery resources have been conducted specifically in Nantucket Sound. Although the best available data are not fully descriptive of the spatial distribution of recreational fishing in Nantucket Sound, little evidence has been found or brought forward by commenters to date to suggest that marine recreational fishing will be adversely affected by the construction and operation of the WTGs.

Few studies exist on the economic value of recreational fishing in Nantucket Sound. Norton et al. (1983) estimate the net value (consumer surplus) to recreational anglers of fishing for striped bass in Massachusetts at $207.26 per day (2005 dollars). Pendelton (2008) reports a range of values from $15 to $100 per visit for coastal and estuary recreational fishing in Massachusetts. Using estimates developed by NOAA Fisheries of recreational fishing effort in Nantucket Sound (reported below), this range suggests that the annual net value of recreational fishing in Nantucket Sound ranges from $10 to $63 million. Valuing shore-based fishing with the lower value and party/charter boat and private/rental boat fishing with the higher value suggests a best estimate of an annual value approximately $25 million for marine recreational fishing in Nantucket Sound. Although it is difficult to make comparisons with incomplete data, given the inefficient regulation of the commercial fisheries, this scale of economic value for recreational fishing may well exceed the net economic value for commercial finfish fishing in Nantucket Sound. (Note that these are net value estimates, unlike the gross value estimates reported above for commercial fisheries.).

The best available data on recreational fishing comprise surveys and monitoring conducted by NOAA Fisheries. NOAA Fisheries uses two methods to monitor recreational fishing activity: a Marine Recreational Fisheries Statistics Survey (MRFSS) and Charter and Party Boat (CPB) vessel trip report (VTR) data. The MRFSS data provide the best estimates of recreational fishing effort and catch, but they include only limited broad-based information on the spatial distribution of recreational fishing. The CPB/VTR data provide information about the spatial distribution of recreational fishing, but they are limited only to CPB fishing on vessels that hold federal licenses (a subset of party/charter boats working in Nantucket Sound). Although MassDMF does not conduct its own surveys of recreational fishing, it provides NOAA Fisheries with financial assistance for carrying out the MRFSS program in Massachusetts' counties.

In addition to NOAA Fisheries recreational fishing surveys and monitoring, the applicant undertook two data collection efforts: an intercept survey was conducted from August 2002 through November 2002, and a survey of commercial and recreational fishing activities was conducted in 2005. These two surveys provide some limited additional information about recreational fishing activity in Nantucket Sound.

**NOAA Marine Recreational Fisheries Statistics Survey (MRFSS)**

The MRFSS methods include both face-to-face and telephone interviews held with recreational anglers in several local seaports. These surveys do not collect information on the specific spatial distribution of recreational fishing, for example by using a statistical sampling grid of coastal waters. During the face-to-face interviews, the county where the survey was held is recorded. During the telephone interviews, the county where anglers indicate participation in recreational fishing is recorded.

The surveys collect information on the general location of fishing activity, the length of time fished, the type of gear used, and the description of species and numbers of fish that were caught and released.

The raw MRFSS data are compiled at the county level and aggregated to state, regional, and national levels. The state, regional, and national-level compilations are available from NOAA online at http://www.st.nmfs.noaa.gov/st1/recreational/queries/index.html. The county level data have been posted on an file transfer protocol site maintained by NOAA: ftp://cusk.nmfs.noaa,gov/mrfss/intercept/ag/. Massachusetts is identified as state number 25; the counties surrounding Nantucket Sound are identified as follows: Barnstable (CNTY=1); Dukes (CNTY=7); and Nantucket (CNTY=19). Report No. 4.2.5-5 provides a compilation and summary of the raw data from 1990 to 2004.

The raw MRFSS data are not measures of total fishing effort or total catch, however. The raw data are a sample of the population of recreational anglers, and the sample must be extrapolated to the population to estimate total recreational fishing effort and total recreational fish catch. Because of limited sample sizes, raw data typically is aggregated to the larger geographic scales (state, region, or nation) to reduce sources of error when making extrapolations. Data analyzed by NOAA for Nantucket Sound utilizing the three relevant Massachusetts counties, although presented at a less aggregated scale, is nevertheless useful in presenting a description of the scale of recreational fishing effort and the nature of fish catches.

The data describing recreational fishing effort and catch are compiled along a number of different dimensions. We present data on fishing mode and fishing area by bimonthly intervals (waves). Fishing modes comprise shore-based fishing, party/charter and private/rental boat fishing. Recreational fishers are surveyed on their geographic fishing areas, including ocean, sound, river, bay, and all other locations. We present data on sound-based fishing only for Barnstable, Dukes, and Nantucket Counties as the data that best characterize recreational fishing in Nantucket Sound. Data are presented for the period 2005 to 2007 (2007 data are unavailable for party/charter boat fishing). Although this is a short time series, these recent years best depict both current and likely near future levels of recreational fishing activity.

Recreational fishing is sampled in bimonthly “waves” as follows: wave 1: January/February; wave 2: March/April; wave 3: May/June; wave 4: July/August; wave 5: September/October; and wave 6: November/December (NOAA Fisheries, 2001). Recreational fishing may take place in Nantucket Sound during the entire year; however, NOAA Fisheries does not survey the New England region during the wave 1 timeframe. Only about five percent of the annual recreational catch along the Atlantic and Gulf coasts occurs during wave 1. The costs of sampling during these months are high due to the low levels of fishing activity, especially in the North- and Mid-Atlantic subregions. Data collection for wave 1 has been continued along the Gulf and Pacific coasts and along the Atlantic Coast of Florida. With the exceptions of Georgia from 1985 to 1989, South Carolina in 1988, and North Carolina from 1988 to 1992, the MRFSS has not been conducted during wave 1 along the Atlantic Coast north of Florida since 1980 (NOAA Fisheries, 2004).

Table 4.2.7-19 presents the NOAA Fisheries estimate of MRFSS recreational fish catches in Nantucket Sound. The catches are measured in pounds, and the top eight species represent 99 percent of the total recreational catch. The leading species include bluefish, scup, striped bass, fluke, black sea bass, little tunny, bonito, and tautog. The estimated recreational catches exceed recorded levels of commercial catches for many of these species (see the tables referenced in Section 4.2.7.2.1 above), although it is understood that the commercial fishing data for Nantucket Sound are incomplete.

Table 4.2.7-20 presents the NOAA Fisheries estimate of MRFSS recreational fishing effort (trips) in Nantucket Sound. The data are presented by bimonthly survey wave (2-6) and by fishing mode (shore, party/charter boat, and private/rental boat). The highest recreational fishing pressure occurs in Nantucket

Sound during the summer months (i.e., June through September) when tourists are vacationing in this region. During 2005-07, the average annual total recreational fishing effort in Nantucket Sound is estimated to be 635,047 trips. Recreational fishing effort peaks during the July-August wave with an annual average of 272,655 trips across all three modes. Average annual shore-based fishing accounts for over 73 percent of average annual effort. Shore-based fishing occurs during all five waves. Average annual party/charter boat fishing effort accounts for only about three percent of the total, although it represents 11 percent of the non-shore average annual effort. Average annual private/rental boat fishing effort represents about 25 percent of the total. Average annual private/rental boat fishing effort accounts for 89 percent of the non-shore total. Clearly private/rental boat fishing it is the most important mode of recreational fishing in Nantucket Sound proper.

**NOAA Fisheries Recreational Vessel Trip Report (VTR) Data: Charter and Party Boats (CPB)**

Table 4.2.7-21 presents the recreational Charter and Party Boat Vessel Trip Report (CPB/VTR) data from NOAA Fisheries for Nantucket Sound (Area 075) during 1994-2007. These data comprise recreational catches for federally-permitted charter or party boats, which are subject to VTR reporting requirements. Federal CPB permits are issued by NOAA Fisheries to vessels involved in recreational catches of black sea bass, bluefish, squid/mackerel/butterfish, scup, summer flounder, and New England multi-species fisheries (groundfish). Federal vessel permits for bluefish were not implemented until 2000 for CPB fisheries (NOAA Fisheries, 2005). Report No. 4.2.5-5 presents additional descriptions of these data from 1994 to 2004.

CPB/VTR recreational catches include finfish, shellfish, and squid. Recreational CPB/VTR catches were reported for federally-permitted vessels during 1994-2007 primarily during the months of April to October. During the ten year period from 1998-2007, federally-reported CPB/VTR recreational catches averaged 40,992 pounds. Reported catches have been increasing over the same period (Table 4.2.7-21). The top ten species include: scup (74 percent of catches), *Loligo* squid, black sea bass, summer flounder, bluefish, tautog, striped bass, and sea robin, (Table 4.2.7-22). These species made up nearly 100 percent of the total federally-reportable recreational species caught during the ten-year period.

Gear types that were used for harvesting recreational species were reported to include both hand line/rod and reel and fish pots, Hand line/rod and reel landings accounted for nearly 100 percent of total federally-reportable recreational CPB landings during 1994 to 2007.

A unique aspect of the CPB/VTR data is that catches are reported by geographic location. The CPB/VTR data are the best available data on the spatial distribution of recreational fishing in Nantucket Sound. Recreational fishing vessels may move around during a trip, but the reported location is representative of where the majority of fishing took place during a trip. Figure 4.2.7-6 depicts the location of catches (in pounds) for the reporting CPB vessels during 1998-2007. The figure shows that most of the CPB/VTR recreational fishing activity is distributed along the northern edge of Nantucket Sound, near the municipalities on Cape Cod that border the sound, and few catches were reported on or near Horseshoe Shoal.

It is possible that the spatial distribution of the federally-permitted charter and party boats could be interpreted as an approximation of the spatial distribution of all recreational fishing activity in Nantucket Sound. Fishing guides who run charter and party boat fishing businesses are regarded as among the most knowledgeable individuals with respect to identifying and utilizing recreational fishing locations with the highest catch rates. In fact, their livelihoods depend upon identifying the most productive locations.

Notwithstanding this interpretation of the potential representativeness of the CPB/VTR data for the geographic distribution of recreational fishing activity in general, some serious limitations to the use of the data for this purpose exist. The CPB/VTR data do not include the location of state-permitted charter and party boats. (MassDMF does not compile data on the spatial distribution of recreational fishing by charter or party boats that hold permits only from Massachusetts.) Further, the CPB/VTR data do not include information on the spatial distribution of party/rental boats, which, according to the MRFSS data represent the great majority (89 percent) of recreational fishing effort in Nantucket Sound.

These limitations to the representativeness of the CPB/VTR data on recreational fishing should be conditioned on at least two points. First, it is known to be hazardous for small craft to fish on Horseshoe Shoal because of the strong currents, waves, and rips (see Section 4.4.3.5 for Report No. 4.4.3-1). These hazards certainly constrain the recreational fishing effort exerted by private/rental boats on Horseshoe Shoal. Second, no comments have been received suggesting that Horseshoe Shoal would be less productive as a consequence of the construction of the WTGs. To the contrary, it is commonly assumed that the scour mats and riprap, either as fish aggregating devices or as enhanced habitat, will lead to increased productivity for recreational fishing. Consequently, those recreational fishing boats (party/charter or private/rental) that are able to safely navigate Horseshoe Shoal may experience increased success and higher catch rates from the construction of the WTGs. This hypothesis would be important to test with a program of research. Both the MRFSS and the CPB/VTR datasets, as well as information from stock assessments, could be very useful for testing this hypothesis.

**Recreational Intercept Survey**

An intercept survey was performed from August 2002 through November 2002 to estimate of fishing by party/charter boats in Nantucket Sound. These types of boats are common platforms for recreational fishing activities, especially for those without access to personal boats. Party boats are those that accept individual passengers on a first-come, first-served basis, taking such individuals fishing for either a half or a full day for a fee. A charter boat is one that is reserved in advance by a small number of anglers who pay a set price for the charter.

One purpose of the 2002 intercept survey was to collect information on existing recreational fishing efforts by party/charter boats in Nantucket Sound for evaluation of the potential impacts of the proposed action on this type of recreational fishing activity. Further, the survey collected information on the species targeted by recreational anglers in Nantucket Sound. The survey was designed to be answered by captains or crew of party/charter boats. Charter boat and registered party boat captains expected to fish in the area were identified, contacted by phone, and questioned. A map indicating the locations of the WTGs and other areas in Nantucket Sound was sent to captains so that they might identify specific fishing locations in the Sound. Report No. 4.2.7-3 presents detailed information on these data.

Thirty charter and party boat captains were contacted and then questioned. Of the 30 respondents, 27 were charter boat operators and three were party boat operators. When party/charter boat operators were asked to estimate the number of days fished during a year, they reported fishing an average of 150 days per year. Some operators indicated that several trips were made each day, thus numbers of days fished may not correspond with total numbers of trips. Party/charter boat captains surveyed reported totals of 430 full-day trips and 1,752 half-day trips. Vessel size determines the number of anglers that can fish from charter or party boats. Charter vessels usually can take five to six anglers whereas party boats were may take as many as 20 to 30 anglers each trip.

Captains of both the charter and party boats indicated that the most sought after species for both types of fishing excursions include scup, striped bass, and various tunas. Other common target species include bluefish, bonito, cod, sea bass, and various sharks. It was reported that most species are caught during trips taken from May through September, months when more people participate in fishing activities on charter and party boats.

Charter and party boat captains were asked about the specific areas where they take anglers for fishing. Most charter and party boat captains reported that for short (half-day) trips they did not take their anglers to Horseshoe Shoal. Areas reported by captains as being frequently fished included the following: the Elizabeth Islands, Squibnocket Beach (Martha's Vineyard), Vineyard Sound, South Beach (Martha's Vineyard), Nauset, Stage Harbor, Buzzards Bay, Old Man, shoreline areas near the Dennis/Harwich, Canyons, regions south of Martha's Vineyard, Muskeget Channel, Nantucket Shoals, and Great Point. Other areas fished on half-day trips, but fished less frequently than the above noted areas include areas around Tuckernuck Island and Monomoy Island.

Survey results showed that charter and party boat captains reported they fish shoal areas around Horseshoe Shoal, Tuckernuck Island, and Monomoy Island on the full day trips. Approximately 56 percent of the 430 full-day trips that were reported in the most recent 12 months were to shoal areas around Monomoy Island, 21 percent were to the Horseshoe Shoal area, and 9 percent were to shoal areas around Tuckernuck Island. The remaining full-day trips were reported to be to regions southeast of Nantucket, to areas east of Monomoy Island, and south of Martha's Vineyard. Report No. 4.2.7-3 presents additional detailed information on the recreational intercept survey.

**Survey of Commercial and Recreational Fishing Activities – 2005**

Information was gathered by survey from recreational and commercial fishermen, shellfish officers, harbormasters, bait and tackle shop employees, and a commercial fish dealer. Recreational fishermen were approached in person and interviewed at several types of boat access locations. Harbormasters, shellfish and coastal officers, and bait and tackle shops were identified using town web sites or through a review of MassDMF's January Massachusetts Saltwater Recreational Fishing Guide. Twenty-three individuals were surveyed in late summer and early fall of 2005. Some of these individuals were interviewed in person, but most were interviewed by phone. Information on categories and numbers of interviewees, selection methodologies, survey methodologies, and summary information on the respondents is presented in detail in Report No. 4.2.5-6.

Information obtained from interviews with eight individuals who described themselves as recreational fishermen gave some information on areas that are fished and species of fish sought. Twenty-five percent (two out of eight fishermen interviewed) reported that they fish some portion of the time on Horseshoe Shoal. Other individuals reported that they only fish areas that are closer to shore (25 percent), they fish near Monomoy (25 percent), they fish only off the Elizabeth Islands and in Vineyard Sound (12.5 percent), and they fish in Nantucket Sound and offshore areas but not on Horseshoe Shoal (12.5 percent). The primary target species were reported to include bluefish and striped bass. Other species reported as targeted include fluke and bonito.

Harbor masters and shellfish wardens who were interviewed reported there were more recreational fishermen than commercial fishermen in their areas of jurisdiction. Edgartown and Yarmouth did, however, report a 50/50 split. Fishing areas preferred for most of the users were in proximity to home port areas. Species reported to be targeted included the following: bluefish, striped bass, scup, mackerel, bottom fish such as fluke, squid and lobster, conch (technically a shellfish), and summer and fall transient species that include false albacore, bonito, shark, and tuna. Details on the findings of this survey are presented in Report No. 4.2.5-6.

**Recreational Fisheries Summary**

Nantucket Sound offers excellent opportunities for recreational fishing, leading to an estimated $25 million in annual net economic value. During 2005-07, the average annual total recreational fishing effort in Nantucket Sound is estimated to be 635,047 trips. Average annual shore-based fishing accounts for over 73 percent of average annual effort. Average annual party/charter boat fishing effort accounts for 11 percent of the non-shore average annual effort. Average annual private/rental boat fishing effort accounts for 89 percent of the non-shore total. Clearly private/rental boat fishing is the most important mode of recreational fishing in Nantucket Sound proper.

The best available data on recreational fishing comprise surveys and monitoring conducted by NOAA Fisheries. The MRFSS data provide the best estimates of recreational fishing effort and catch, but they include only limited broad-based information on the spatial distribution of recreational fishing. The CPB/VTR data provide information about the spatial distribution of recreational fishing, but they are restricted only to CPB fishing on vessels that hold federal licenses (a subset of party/charter boats working in Nantucket Sound). Two additional data collection efforts initiated by the project proponent, a 2002 intercept survey and a 2005 telephone survey, provide some limited anecdotal information about recreational fishing activity in Nantucket Sound. These surveys reveal that Horseshoe Shoal is one of several locations utilized by party/charter boats and private/rental boats for targeting the primary recreational species, including bluefish, scup, striped bass, fluke, black sea bass, little tunny, bonito, tautog, and others.

Clearly the best available data are not fully descriptive of the spatial distribution of recreational fishing in Nantucket Sound. These data include government surveys and monitoring as well as intercept and telephone surveys conducted by project proponent. The latter involve small sample sizes that raise questions about the statistical reliability of their conclusions. Little evidence has been found or brought forward by commenters to date, however, to suggest that marine recreational fishing will be adversely affected by the construction and operation of the WTGs. Both the MRFSS and the CPB/VTR datasets, as well as information from stock assessments, could be very useful for testing a null hypothesis that there will be no affect of the construction and operation of WTGs on marine recreational fishing activity in Nantucket Sound.

### 4.2.8 Essential Fish Habitat (EFH)

#### *4.2.8.1 Introduction*

A requirement of the 1996 amendments to the Magnuson-Stevens Act is that an EFH consultation and assessment be conducted for activities that may adversely affect important habitats of federally-managed marine and anadromous fish species. The following is a summary of the EFH assessment (the full EFH assessment is provided in Appendix H). The definition of EFH is “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity” (16 U.S.C. 1802(10). In the definition the term “waters” refers to the physical, chemical, and biological properties of aquatic areas that are currently being used or have historically been used by fish and certain designated invertebrates. In the definition the term “substrate” refers to sediment, hard bottom, or other underwater structures and their biological communities. In the definition the term “necessary” indicates the habitat is required to sustain the fishery and support the fish species’ contribution to a healthy ecosystem. Nantucket Sound has been designated as EFH for twenty fish and invertebrate species that are introduced in the EFH Assessment description below. In addition, the EFH process involves the designation of habitat areas of particular concern (HAPC) for those habitat areas determined to be of particular importance to the survival and growth of a particular species. An EFH Assessment was conducted for these species as they relate to proposed action activities.

Habitat in the proposed action locale has been designated EFH for 17 federally-managed fish and three federally-managed invertebrates. The Magnuson-Stevens Act requires assessment of the potential impacts to the 17 federally-managed fish and three federally-managed invertebrates. These species include the following: Atlantic cod (*Gadus morhua*), scup (*Stenotomus chrysops*), black sea bass (*Centropristis striata*), winter flounder (*Pseudopleuronectes americanus*), windowpane (*Scophthalmus* *aquosus*), summer flounder (*Paralichthys dentatus*), yellowtail flounder (*Limanda ferruginea*), Atlantic butterfish (*Peprilus triacanthus*), Atlantic mackerel (*Scomber scombrus*), blue shark (*Prionace glauca*), shortfin mako shark (*Isurus oxyrhinchus*), bluefin tuna (*Thunnus thynnus*), king mackerel (*Scomberomorus cavalla*), Spanish mackerel (*Scomberomorus maculatus*), cobia (*Rachycentron canadum*), little skate (*Leucoraja erinacea*), winter skate (*Leucoraja ocellata*), long-finned squid (*Loligo pealei*), short-finned squid (*Illex illecebrosus*), and the surf clam (*Spisula solidissima*). A summary of specific life stage EFH designations for these species is provided in Table 4.2.8-1. One EFH HAPC has been identified in the proposed action locale. Eelgrass beds, when located within summer flounder EFH, have been designated as an HAPC by MAFMC. Descriptions of potential direct and indirect impacts of the proposed action to these species and their associated habitat are discussed in Section 5.3.2.8 and are further detailed in the EFH Assessment.

### *4.2.8.2 Life History Characteristics of Species with EFH Designation*

In addition to the life history characteristics of the species with designated EFH in the proposed action area, information is also provided on the occurrence of these species based on several available databases. Although the species presented in Section 4.2.8.1 are reported by NOAA Fisheries to have designated EFH in the four 10 x 10 minute grid squares that encompass the proposed action area, NOAA Fisheries and MassDMF databases were analyzed to determine the occurrence and relative reported landings of these species in Nantucket Sound. While it is understood that the EFH designations are partially based on abundance data from NOAA's Estuarine Living Marine Resources (ELMR) program and other sources and that EFH can be designated based on the habitat that support species and lifestages and not the actual presence of certain species, however, to tie EFH designations to actual occurrence and relative abundance as documented in landings and other available resource data, results from these databases were reviewed. These are summarized in Section 4.2.8.3 below and in Appendix A of the EFH Assessment. Report No. 4.2.7-2 provides more extensive and detailed information on the forage characteristics of the EFH species. Life history characteristics for each EFH species are presented below.

#### 4.2.8.2.1 Demersal Species

**Atlantic cod *(Gadus morhua)***

Adults. EFH for adult Atlantic cod is designated as those bottom habitats with substrates of rocks, pebbles, or gravel in the Gulf of Maine, Georges Bank, southern New England, and the middle Atlantic south to Delaware Bay. Nantucket Shoals exists as a migration point for adults in the Mid-Atlantic Bight during summer and fall as southern water temperatures exceed 68 °F (20 $^{o}$C) (Heyerdahl and Livingstone, 1982). MassDMF trawl surveys (Fahay et al., 1999) in Massachusetts found adults occur more frequently in spring than in fall, but are rare for both seasons in Nantucket Sound. Consequently, the ELMR database indicates that adult cod are common in the Sound during the colder months, from October to April. In the spring, adult cod occur abundantly around Cape Ann, the tip of Cape Cod, and the western part of Cape Cod Bay. Few were found during fall, and those were restricted to the Cape Ann and Cape Cod tip areas. Adult cod are typically found on or near bottom along rocky slopes and ledges, preferring depths between 131 and 427 ft (40 to 130 m), but are sometimes found at mid-water depths (Fahay et al., 1999). NMFS has designated all of Nantucket Sound as EFH for this life stage.

Forage Species. Juvenile cod are bottom-dwelling and feed mainly upon small crustaceans such as shrimp and amphipods (Marine Fisheries, 2005). However, although studies have shown that the most frequently consumed food items by adult cod are invertebrates (Fahay et al., 1999), they will in fact eat almost anything small enough to fit into their mouths, including clams, cockles, mussels, and other mollusks, as well as crabs, lobsters, and sea urchins (Marine Fisheries, 2005). Adults also pursue schooling fish, eating substantial numbers of herring, shad (*Alosa spp.*), mackerel, and silver hake (*Merluccius bilinearis*) (Marine Fisheries, 2005).

**Scup *(Stenotomus chrysops)***

*Juveniles*. For juvenile scup, EFH is designated as the demersal waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH in inshore waters includes all estuaries and bays where juvenile scup were identified as being common, abundant or highly abundant in the ELMR database for the "mixing" (0.5 to 25.0 ppt) and "seawater" (>25 ppt) salinity zones between Massachusetts and Virginia, in association with various sands, mud, mussel, and eelgrass bed type substrates. Juveniles are common and highly abundant in Nantucket Sound from May to October as indicated in the ELMR database. As inshore water temperatures decline to less than 46 to 48°F (8 to 9°C) in winter, scup leave inshore waters and move to warmer waters in the Mid-Atlantic Bight, returning inshore with rising temperatures in the spring (Steimle et al., 1999b). Juveniles will often use biogenic depressions, sand wave troughs, and possibly mollusk shell fields for shelter in winter (Steimle et al., 1999b).

*Adults*. EFH for adult scup is designated as those demersal waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH in inshore waters includes all estuaries where adult scup were identified as being common, abundant or highly abundant in the ELMR database for the "mixing" (0.5 to 25.0 ppt) and "seawater" (>25 ppt) salinity zones. Adults are highly abundant in Nantucket Sound from May to September and common in October as indicated in the ELMR database. The distribution and abundance of adult scup off New England is temperature dependent (Mayo, 1982; Gabriel, 1992). As inshore water temperatures decline to less than 46 to 48 °F (8 to 9 °C) in winter, scup leave inshore waters and move to warmer waters in the Mid-Atlantic Bight (Steimle et al., 1999b). Thus, wintering adults (November through April) are primarily offshore, south of New York to North Carolina relative to the location of the 45 °F (7 °C) bottom isotherm, their lower preferred limit (Neville and Talbot, 1964). With rising temperatures in the spring, scup return inshore (Steimle et al., 1999b).

*Forage species*. Scup are benthic feeders, adult scup forage upon a variety of prey including zooplankton, small crabs, amphipods, cnidarians, squid, polychaetes, clams, mussels, snails, sand dollars, insect larvae, and vegetative detritus (Ross, 1991; Steimle et al., 1999b; Marine Fisheries, 2005). Smaller scup eat a larger proportion of cnidarians, polychaetes, amphipods, and mysid shrimp, whereas larger scup consume more squids and fishes (Collette and Klein-MacPhee, 2002).

**Black sea bass *(Centropristis striata)***

*Larvae*. For larval black sea bass, EFH is designated as the pelagic waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH in inshore waters includes all the estuaries where larval black sea bass were identified as being common, abundant or highly abundant in the ELMR database for the "mixing" (0.5 to 25.0 ppt) and "seawater" (>25 ppt) salinity zones. Larval black sea bass are not yet compiled in the ELMR database. Based on New England Fisheries Science Center (NEFSC) Marine Resources Monitoring Assessment and Prediction Program (MARMAP) ichthyoplankton surveys (Steimle et al., 1999a), larvae are generally found at water temperatures of 52 to 79 °F (11 to 26 °C) (55 to 70 °F [13 to 21 °C] preferred range). They were also collected at depths less than 328 ft (100 m), but several collections during May-July and October occurred over deeper (>656 ft [>200 m]) waters. The habitats for transforming (to juveniles) larvae are near the coastal areas and into marine parts of estuaries between New York and Virginia. When larvae become demersal, they are generally found on structured inshore habitat.

*Juveniles*. The demersal waters over the continental shelf, from the Gulf of Maine to Cape Hatteras, are designated as EFH for juvenile black sea bass. EFH in inshore waters includes all estuaries where juvenile black sea bass were identified as being common, abundant or highly abundant in the ELMR database for the "mixing" (0.5 to 25.0 ppt) and "seawater" (>25 ppt) salinity zones. Juveniles are common in Nantucket Sound from May to October as indicated in the ELMR database. Most juvenile settlement does not occur in estuaries, but in coastal areas (Steimle et al., 1999a). Recently settled juveniles then find their way into estuarine nurseries, where they will co-exist with other fish species in and around oyster beds (Steimle et al., 1999a). Older juveniles return to estuaries in late spring and early summer, and may follow the migration routes of adults into coastal waters (Steimle et al., 1999a). However, all juveniles seem to winter offshore, from New Jersey southward. Juvenile black sea bass are associated with rough and hardbottom substrate, shellfish and eelgrass beds, and man-made structures in sandy/shelly areas, as well as offshore clam beds and shell patches during the wintering. Some individuals may spend the warmer months along the coast in accumulations of surf clam and ocean quahog shells (Able et al., 1995).

Adults. EFH for adult black sea bass is also designated as those demersal waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH in inshore waters includes all estuaries where adult black sea bass were identified as being common, abundant or highly abundant in the ELMR database for the "mixing" (0.5 to 25.0 ppt) and "seawater" (>25 ppt) salinity zones. Adults are common in Nantucket Sound from May to October as indicated in the ELMR database. They are heavily associated with man-made structures, rough and hardbottom substrate along the sides of navigational channels (Steimle et al., 1999a), shellfish and eelgrass beds, and sandy/shelly areas. Studies (Mercer, 1989) have found adult black sea bass to prefer depths of 66 to 197 ft (20 to 60 m).

*Forage species*. Juveniles feed upon a variety of benthic organisms such as shrimp, isopods and amphipods with mysid shrimp constituting more than half their food intake (Ross, 1991). Adults commonly feed upon rock crabs (*Cancer spp*.) and hermit crabs (*Pagurus spp*.) as well as other crustaceans (Ross, 1991) including juvenile American lobster (*Homarus americanus*) (Steimle et al., 1999a), mollusks and squid (Ross, 1991). Adults also occasionally graze upon attached organisms such as barnacles and colonial tunicates (Ross, 1991) as well as razor clams (*Siliqua patula*) (Marine Fisheries, 2005). Fishes including herring and anchovies (*Anchoa spp*.) are also a major component of the adult diet as well as other species such as, scup, sand lance and windowpane (Collette and Klein-MacPhee, 2002).

#### 4.2.8.2.2 Demersal Groundfish Species

**Winter flounder *(Pseudopleuronectes americanus)***

Eggs. EFH for winter flounder eggs consists of bottom habitat with a substrate of sand, muddy sand, mud, and gravel on Georges Bank, the inshore areas of the Gulf of Maine, southern New England, and the middle Atlantic south to the Delaware Bay. However, sand appears to be the most common associated substrate (Pereira et al., 1999). Winter flounder eggs are not yet compiled in the ELMR database.

Larvae. EFH for larval winter flounder is designated as pelagic and bottom waters of Georges Bank, the inshore areas of the Gulf of Maine, southern New England, and the middle Atlantic south to the Delaware Bay. Winter flounder larvae are not yet compiled in the ELMR database.

"*Young-of-the-Year" Juveniles*. Winter flounder less than one year old (Young-of-the-Year, or YOY) are treated separately for this species because their habitat requirements are different from that of larger juveniles (>1 year) (Pereira et al., 1999). EFH includes bottom habitat with a substrate of mud or sand on Georges Bank, the inshore areas of the Gulf of Maine, southern New England, and the middle Atlantic south to Delaware Bay. Many studies reviewed in Pereira et al. (1999) confirm young winter flounder are plentiful along the east coast, especially in Massachusetts. In southern New England, newly metamorphosed YOY juveniles take up residence in shallow water where they may grow to larger juvenile sizes within the first year (Bigelow and Schroeder, 1953). Sandy coves appear to be the preferred habitat in the very shallow waters of estuaries and bays where they were spawned (Hildebrand and Schroeder, 1928). However, recent comparisons of habitat-specific patterns of abundance and distribution of YOY winter flounder in many Mid-Atlantic estuaries support the conclusion that habitat utilization by YOY winter flounder is not consistent across habitat types and is highly variable among systems and from year to year (Pereira et al., 1999; Goldberg et al., in prep).

Age 1+ Juveniles. Winter flounder juveniles older than one year have EFH in bottom habitats with a substrate of mud or fine-grained sand on Georges Bank, the inshore areas of the Gulf of Maine, southern New England, and the middle Atlantic south to the Delaware Bay. Juveniles are common, abundant, and highly abundant throughout the year in Nantucket Sound as indicated in the ELMR database. Older juveniles inhabiting estuaries gradually move seaward as they grow larger (Mulkana, 1966).

Adults. EFH for adult winter flounder consists of bottom habitat, including estuaries, with a substrate of mud, sand, and gravel on Georges Bank, the inshore areas of the Gulf of Maine, southern New England, and the middle Atlantic south to the Delaware Bay. Adults are common, abundant, and highly abundant throughout the year in Nantucket Sound as indicated in the ELMR database. Traditionally, New England and the New York Metropolitan area have contained the most abundant populations (NUSC, 1989). MassDMF (2001b) survey trawls on Horseshoe Shoal have found winter flounder are relatively common during spring and rare during fall within the proposed action area.

Spawning Adults. For spawning winter flounder, EFH consists of bottom habitat, including estuaries, with a substrate of sand, mud, muddy sand, and gravel on Georges Bank, the inshore areas of the Gulf of Maine, southern New England, and the middle Atlantic south to the Delaware Bay. Winter flounder adults undertake small-scale migrations into estuaries, embayments, and saltwater ponds from winter through spring to spawn. Winter flounder are most often observed spawning during the months of February to June with the peak spawning occurring during February and March south of Cape Cod (Goldberg et al., in prep). Typically, eggs are deposited over a sandy substrate at depths of 6.6 to 262.5 ft (2 to 80 m) (Bigelow and Schroeder, 1953), although most spawning takes place at depths less than 16.4 ft (5 m). Major egg production occurs in New England waters before temperatures go below 37.9 °F (3.3 °C) (Bigelow and Schroeder, 1953). After spawning, adults may remain in the spawning areas before moving to deeper waters when water temperatures reach 59 °F (15 °C) (McCracken, 1963).

Forage species. Winter flounder have been described as omnivorous or opportunistic feeders, consuming a wide variety of prey; polychaetes and crustaceans (mostly amphipods) generally make up the bulk of the diet (Pereira et al., 1999). Juveniles feed heavily upon copepods, nemerteans, ostracods, amphipods, and polychaetes (Ross, 1991; Buckley, 1989). Adults feed primarily upon polychaetes, anthozoans (e.g., anemones) and amphipods (Bowman et al., 2000) however they also feed upon a great variety of other organisms including shrimp, small crabs, mollusks, squids, fish eggs, fish fry, vegetation, (Bowman et al., 2000; Ross, 1991) and rarely they will also eat fishes such as sand lance (Collette and Klein-MacPhee, 2002).

**Summer flounder or fluke *(Paralichthys dentatus)***

Eggs. EFH for summer flounder eggs is designated as those pelagic waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. Summer flounder eggs are not yet compiled in the ELMR database. Generally, summer flounder eggs are found between October and May, being most abundant between Cape Cod and Cape Hatteras, with the heaviest concentrations within 9 miles (14.5 km) offshore of New Jersey and New York. Able et al. (1990) found the highest frequencies of occurrence and greatest abundances of eggs in the northwest Atlantic occur in October and November. However, due to limited sampling in areas of southern New England in the month of December, this lifestage could be under represented.

Larvae. The pelagic waters over the continental shelf, from the Gulf of Maine to Cape Hatteras, are designated as EFH for summer flounder larvae. EFH in inshore waters includes all the estuaries where larval summer flounder were identified as being present (rare, common, abundant or highly abundant) in the ELMR database for the "mixing" (0.5 to 25.0 ppt) and "seawater" (>25 ppt) salinity zones. Larvae are not yet compiled in the ELMR database. They are most frequently found in the northern part of the Mid-Atlantic Bight from September to February.

*Juveniles*. EFH for juvenile summer flounder consists of the demersal waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH in inshore waters includes all estuaries where juvenile summer flounder were identified as being present (rare, common, abundant or highly abundant) in the ELMR database for the "mixing" (0.5 to 25.0 ppt) and "seawater" (>25 ppt) salinity zones. Juveniles are rare in Nantucket Sound from May to October as indicated by the ELMR database. In estuaries north of Chesapeake Bay, some juveniles remain in their estuarine habitat for 10 to 12 months before migrating offshore their second fall and winter (Packer et al., 1999). Generally, juvenile summer flounder use several different estuarine habitats as nursery areas, including salt marsh creeks, seagrass beds, mudflats, and open bay areas in a salinity range of 10 to 30 ppt.

*Adults*. Like juveniles, EFH for adult summer flounder also consists of the demersal waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH in inshore waters includes all estuaries where adult summer flounder were identified as being present (rare, common, abundant or highly abundant) in the ELMR database for the "mixing" (0.5 to 25.0 ppt) and "seawater" (>25 ppt) salinity zones. Adults are common in Nantucket Sound from May to October as indicated by the ELMR database. The preferred substrate is sand, which is used to conceal themselves from predators and thus avoid predation. Summer flounder in Massachusetts migrate inshore in early May and occur along the entire shoal area south of Cape Cod and Buzzards Bay, Vineyard Sound, Nantucket Sound, and the coastal waters around Martha's Vineyard (Howe et al., 1997). MassDMF considers the shoal waters of Cape Cod Bay and the region east and south of Cape Cod, including all estuaries, bays, and harbors thereof, as critically important habitat (Packer et al., 1999). All of these designated areas are outside of the proposed action area and alternative sites in Nantucket Sound.

Studies by Burke (1991) and Burke et al. (1991) have made it clear that the summer flounder's distribution is due to substrate preference and is not affected by salinity. Summer flounder occupy a variety of habitats over sand, mud, and vegetated substrate including marsh creeks (Able and Fahay, 1998). Generally, adult summer flounder inhabit shallow coastal and estuarine waters during spring and summer, then move offshore during late summer and fall to the OCS to depths of 558 ft (170 m). Some evidence suggests that older adults may remain offshore all year (Festa, 1977).

HAPC for summer flounder is defined as all native species of macroalgae, seagrasses, and freshwater and tidal macrophytes in any size bed, as well as loose aggregations, within adult and juvenile summer flounder EFH.

*Forage species*. Juveniles and smaller adults feed mostly upon mysid shrimp and other crustaceans (Ross, 1991; Collette and Klein-MacPhee, 2002), adults eat a variety of fishes, including small winter flounder, menhaden, sand lances, red hakes, silver hakes, anchovies, silversides, bluefish, weakfish, and mummichogs, as well as invertebrates such as blue crabs, squid, sand shrimp (*Crangon septemspinosa*), and mollusks (Ross, 1991; Collette and Klein-MacPhee, 2002). Weakfish, winter flounder and sand lance have been found to constitute the greatest volume of food eaten by summer flounder, although sand shrimp are also a major food for both juveniles and adults (Ross, 1991; Collette and Klein-MacPhee, 2002).

**Windowpane *(Scophthalmus aquosus)***

Adults. For adult windowpane, EFH exists in bottom habitats with a substrate of sand, fine-grained sand, or mud around the perimeter of the Gulf of Maine, on Georges Bank, southern New England, and the middle Atlantic south to the Virginia-North Carolina border. Adults are common and abundant in Nantucket Sound throughout the year as indicated by the ELMR database. Adults occur primarily on sand substrates off southern New England (Chang et al., 1999). MassDMF (2001b) survey trawls on Horseshoe Shoal have found windowpane are relatively common during spring and rare during fall within the proposed action area.

Spawning Adults. Spawning windowpane have designated EFH in bottom habitats with a substrate of mud or fine-grained sand in the Gulf of Maine, on Georges Bank, southern New England, and the middle Atlantic south to Cape Hatteras. Aggregations of adults south of Cape Cod in spring suggest spawning activities may occur in the proposed action area (Chang et al., 1999). The seabed sediment composition of Nantucket Sound primarily consists of sand. Since the preference for spawning adults is fine-grained sand or mud, spawning activities may occur in the proposed action area. However, NMFS has not designated EFH in the proposed action area for eggs.

Forage species. The three major components of the windowpane diet are mysid shrimp, fishes and decapods (Bowman et al., 2000). Other prey items include chaetognaths, squids, mollusks, ascidians (sea squirts), polychaetes, cumaceans, isopods, amphipods, sand shrimp, and euphausiids (Bowman et al., 2000; Collette and Klein-MacPhee, 2002; Ross, 1991). Windowpane over 7.9 inches (20 cm) also feed on the aforementioned items but in addition prey on juvenile fishes such as anchovies, silver hake, tomcod, killifishes (i.e., mummichog and striped killifish), pipefish, longhorn sculpin, striped bass, sand lance, pollock, herring, and flatfishes (Bowman et al., 2000; Collette and Klein-MacPhee, 2002; Ross, 1991) as well as their own species (Chang et al., 1999).

**Yellowtail flounder *(Limanda ferruginea)***

Juveniles. EFH for juvenile yellowtail flounder is not present in Nantucket Sound but is within other areas of the designated EFH squares overlapping with Nantucket Sound. NMFS has not appointed specific regions of EFH in Nantucket Sound for this life stage (NEFMC, 1998).

#### 4.2.8.2.3 Coastal Pelagic Species

**Atlantic butterfish *(Peprilus triacanthus)***

Eggs. EFH for butterfish eggs is designated as those pelagic waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH in inshore waters includes the “mixing” (0.5 to 25.0 ppt) and “seawater” (>25 ppt) portions of all estuaries where Atlantic butterfish eggs were identified as being common, abundant or highly abundant on the Atlantic coast, from Passamaquoddy Bay, Maine to James River, Virginia. Atlantic butterfish eggs are not yet compiled in the ELMR database, but are considered common in Massachusetts Bay, Cape Cod Bay, Waquoit Bay, and Buzzards Bay (Cross et al., 1999).

Larvae. EFH for Atlantic butterfish larvae consists of those pelagic waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH for inshore waters includes the “mixing” (0.5 to 25.0 ppt) and “seawater” (>25 ppt) portions of all the estuaries where Atlantic butterfish larvae were identified as being common, abundant or highly abundant on the Atlantic coast, from Passamaquoddy Bay, Maine to James River, Virginia. Atlantic butterfish eggs are not yet compiled in the ELMR database, but are considered common in Buzzards Bay and Waquoit Bay (Cross et al., 1999).

*Juveniles*. EFH for juvenile butterfish is designated as those pelagic waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH in inshore waters includes the "mixing" (0.5 to 25.0 ppt) and "seawater" (>25 ppt) portions of all the estuaries where juvenile Atlantic butterfish were identified as being common, abundant or highly abundant on the Atlantic coast, from Passamaquoddy Bay, Maine to James River, Virginia. Juveniles are abundant in Nantucket Sound from June to October, and common in November as indicated by the ELMR database.

*Adults*. EFH for adult butterfish also consists of the pelagic waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH in inshore waters includes the "mixing" (0.5 to 25.0 ppt) and "seawater" (>25 ppt) portions of all the estuaries where adult Atlantic butterfish were identified as being common, abundant or highly abundant on the Atlantic coast, from Passamaquoddy Bay, Maine to James River, Virginia. Adults are abundant in Nantucket Sound from June to October, and common in May and November as indicated by the ELMR database. Several studies in Cross et al. (1999) reveal adults will inhabit high salinity and mixed salinity zones of most estuaries from the Gulf of Maine to Florida. MassDMF (2001b) survey trawls on Horseshoe Shoal have found butterfish are rare during spring and more common during fall within the proposed action area.

*Forage Species*. In general butterfish predominantly prey upon urochordates (tunicates), but also are known to feed upon cnidarians (i.e., jellyfish, hydroids, anemones) and a wide variety of planktonic organisms (Bowman et al., 2000). Some other common prey items include mollusks (primarily squids), crustaceans (copepods, amphipods, and decapods), polychaetes, and small fishes (Cross et al., 1999). In addition, a ctenophore (comb jelly) (*Mnemiopsis leidyi*) has been shown to be an important component of the diet of butterfish juveniles in Narragansett Bay, R.I. (Collette and Klein-MacPhee, 2002).

**Atlantic mackerel *(Scomber scombrus)***

*Eggs*. EFH for Atlantic mackerel eggs is designated as those pelagic waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH in inshore waters includes the "mixing" (0.5 to 25.0 ppt) and "seawater" (>25 ppt) portions of all the estuaries where Atlantic mackerel eggs were identified as being common, abundant or highly abundant on the Atlantic coast, from Passamaquoddy Bay, Maine to James River, Virginia. Based on a Massachusetts coastal zone survey in Studholme et al. (1999), eggs in Nantucket Sound occur only randomly.

*Larvae*. EFH for Atlantic mackerel larvae is also designated as those pelagic waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH in inshore waters includes the "mixing" (0.5 to 25.0 ppt) and "seawater" (>25 ppt) portions of all the estuaries where larval Atlantic mackerel were identified as being common, abundant or highly abundant on the Atlantic coast, from Passamaquoddy Bay, Maine to James River, Virginia. Atlantic mackerel larvae are not yet compiled in the ELMR database. Based on a Massachusetts coastal zone survey in Studholme et al. (1999), larvae in Nantucket Sound occur only randomly.

*Juveniles*. EFH for juvenile Atlantic mackerel is designated as those pelagic waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH in inshore waters includes the "mixing" (0.5 to 25.0 ppt) and "seawater" (>25 ppt) portions of all the estuaries where juvenile Atlantic mackerel were identified as being common, abundant or highly abundant on the Atlantic coast, from Passamaquoddy Bay, Maine to James River, Virginia. Juveniles are common in Nantucket Sound from August to November as indicated by the ELMR database. Based on a Massachusetts coastal zone survey in Studholme et al. (1999), juveniles in Nantucket Sound occur only randomly.

*Adults*. For adult Atlantic mackerel, EFH is also designated as those pelagic waters found over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH in inshore waters includes the "mixing"

(0.5 to 25.0 ppt) and "seawater" (>25 ppt) portions of all the estuaries where adult Atlantic mackerel were identified as being common, abundant or highly abundant on the Atlantic coast, from Passamaquoddy Bay, Maine to James River, Virginia. Adults are common in Nantucket Sound in March, April, and from October to December as indicated by the ELMR database. Based on a Massachusetts coastal zone survey in Studholme et al. (1999), adults in Nantucket Sound occur only randomly.

Forage species. These fish are opportunistic feeders that swallow prey whole. Food is acquired either through filter feeding or pursuit of individuals (Studholme et al., 1999). Juveniles will eat mostly small crustaceans such as copepods, amphipods, mysid shrimp (*Mysis spp*.), and decapod larvae (Studholme, 1999). Adults feed on the same foods as juveniles but their diet will additionally include larger prey items such as squid, silver hake, sand lance (*Ammodytes spp*.), and small herring (Collette and Klein-MacPhee, 2002) as well as young mackerel (Ross, 1991).

### 4.2.8.2.4 Coastal Migratory Pelagic Species

The general NMFS EFH designation (NOAA Fisheries Service, 2006) for all the Coastal Migratory Pelagic Species listed below, except the bluefin tuna, includes the sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters, from the surf to the shelf break zone, but from the Gulf Stream shoreward (including *Sargassum*), coastal inlets, and tidal estuaries. In addition, all coastal inlets in the South and Mid-Atlantic Bight are state-designated nursery habitats of particular importance to these species as well. However, the following species do not have a management plan in the North Atlantic, and are currently managed within the jurisdiction of the South Atlantic Fisheries Management Council. All are considered rare in Nantucket Sound, as their preference lies in warmer waters south of Chesapeake Bay. Therefore, no specific EFH designations exist within the proposed action area. More specific habitat characteristics taken from literature review and desktop analyses are described below.

**Bluefin tuna *(Thunnus thynnus)***

EFH is not present for the designated lifestages of bluefin tuna in the proposed action area within Nantucket Sound but is located further offshore within the designated EFH blocks that overlap with Nantucket Sound.

**King mackerel *(Scomberomorus cavalla)***

Eggs. Studies in Godcharles and Murphy (1986) reveal that king mackerel spawn in the coastal waters of the northern Gulf of Mexico, and off the southern Atlantic coast. There does not appear to be a well-defined area for spawning, but warm waters are preferred. There is no documentation found of king mackerel eggs occurring at any regularity within the proposed action area, which has physical properties that are inconsistent with its preferred habitat characteristics.

Larvae. King mackerel larvae have been collected near the surface on the Atlantic coast from May through October in surface water temperatures of 78.8 to 87.8 °F (26 to 31 $^{o}$C) and in a salinity range of 26 to 37 ppt (Godcharles and Murphy, 1986). Larval distribution indicates that spawning occurs in the western Atlantic off the Carolinas, Cape Canaveral and Miami, Florida. There does not appear to be a well-defined area for spawning. There is no documentation found of king mackerel larvae occurring at any regularity within the proposed action area, which has physical properties that are inconsistent with its preferred habitat characteristics.

Juveniles. There is no documentation found of juvenile king mackerel occurring at any regularity within the proposed action area, which has physical properties that are inconsistent with its preferred habitat characteristics. However, a small amount of landings have been reported from state-reportable fish weirs in Nantucket Sound according to the MassDMF commercial database.

Adults. King mackerel adults range from the Gulf of Maine to Rio de Janeiro, Brazil. However, they are most commonly found from the Chesapeake Bay southward (Chesapeake Bay Program, 2006). Migratory patterns are driven heavily by water temperature, preferring those greater than 68 °F (20 $^{o}$C). There is no documentation found of adults occurring at any regularity within the proposed action area, which has physical properties that are inconsistent with its preferred habitat characteristics. However, a small amount of landings have been reported from state-reportable fish weirs in Nantucket Sound according to the MassDMF commercial database.

Forage species. King mackerel are primarily pelagic carnivores, principally piscivorous but also showing a preference for invertebrates (Godcharles and Murphy, 1986). They feed primarily on fishes and in smaller quantities on squid (Collette and Klein-MacPhee, 2002). Menhaden are also an important prey species as well as other mackerel (Bowman et al., 2000).

**Spanish mackerel *(Scomberomorus maculatus)***

All life stages of Spanish mackerel are primarily seen in waters above 63.9 °F (17.7 $^{o}$C) and within a salinity range of 32 to 36 ppt (Godcharles and Murphy, 1986). There is no documentation found of Spanish mackerel lifestages occurring at any regularity within the proposed action area, which has physical properties that are inconsistent with its preferred habitat characteristics.

**Cobia *(Rachycentron canadum)***

There is no documentation found of cobia eggs, larvae, or juveniles occurring at any regularity within the proposed action area, which has physical properties that are inconsistent with its preferred habitat characteristics. Cobia adults range from Cape Cod to Argentina. They undergo extensive migrations from overwintering grounds near the Florida Keys to more northerly spawning/feeding grounds in spring and summer months (Richards, 1967). Cobia can be found in high salinity bays, estuaries, and seagrass habitat in a variety of locations over mud, gravel, or sand bottoms, coral reefs, and man-made sloughs. They often congregate along reefs and around buoys, pilings, wrecks, anchored boats, and other stationary or floating objects. There is no documentation found of adult cobia occurring at any regularity within the proposed action area, which has physical properties that are inconsistent with its preferred habitat characteristics.

#### 4.2.8.2.5 Sharks

The following shark species would most likely be rare around the proposed action area due to their preference for deeper waters outside of Nantucket Sound. Personal communications with the NMFS office in Gloucester, Massachusetts indicated that shark species EFH is located more offshore on the OCS, outside of Nantucket Sound.

**Blue shark *(Prionace glauca)***

Adults. Blue shark adults inhabit the pelagic, surface waters of tropical, subtropical, and temperate oceans worldwide. They are commonly found in the Cape Cod area during the summer months (New England Sharks, 2006), moving out to deeper water in late fall and winter (DFO, 2006). Blue sharks are not expected to occur within the proposed action area and were not documented in any of the agency databases for Nantucket Sound (see Appendix A of the EFH Assessment).

Forage species. A large proportion of the diet of the adult blue sharks in western Atlantic waters is made up of squid and octopods (Bowman et al., 2000). Fishes also constitute an important part of the blue sharks diet, with bluefish and red and silver hakes the most important, and mackerel, menhaden, Atlantic herring, and blueback herring also being common forage items (Ross, 1991).

**Shortfin mako shark *(Isurus oxyrhinchus)***

Late Juveniles/Subadults. EFH exists for juvenile shortfin mako sharks in the offshore waters between Cape Cod and Onslow Bay, NC, between the 82 and 6,652 foot (25 and 2000 m) isobaths; and extending west between 38$^{o}$N and 41.5$^{o}$N to the EEZ boundary. It is most commonly seen in offshore waters from Cape Cod to Cape Hatteras (Passarelli et al., 2006). Shortfin mako sharks are not expected to occur within the proposed action area.

Forage species. The mako feeds heavily upon a variety of fish species; one of the most important of these is the bluefish although mako will also eat small bodied schooling species such as mackerel and herring and larger fishes such as swordfish, bonito and tuna (Ross, 1991). Other fish species found in shortfin mako stomachs include blue shark, eel, menhaden, and butterfish (Bowman et al., 2000). In addition, squid are also commonly eaten but generally only in offshore areas (Collette and Klein-MacPhee, 2002).

#### 4.2.8.2.6 Skates

**Little skate *(Leucoraja erinacea)***

Juveniles. EFH for juvenile little skate has been designated for the areas of highest relative abundance for this species based on NMFS trawl survey (1963 to 1999) and ELMR data. Only habitats with sandy, gravelly, or mud substrates that occur within these areas of high abundance are designated as EFH (NOAA, 2006).

NEFSC bottom trawl surveys conducted between 1963 and 2002 (Reid et al., 1999) captured juvenile little skate year-round and showed that in the winter, juveniles were found from Georges Bank to Cape Hatteras, out to the 200 m (656 ft) depth contour, but were almost entirely absent from the Gulf of Maine. In spring they were also found from Georges Bank to Cape Hatteras, but were also heavily concentrated nearshore throughout the Mid-Atlantic Bight and southern New England as well as in Cape Cod and Massachusetts Bays. Both the spring and fall 1978-2002 Massachusetts inshore trawl surveys (Reid et al., 1999) show nearly identical abundances and distributions of juveniles around Nantucket and in Nantucket Sound, in Cape Cod Bay, along the Massachusetts coast and Broad Sound, and north of Cape Ann, with higher concentrations west and south of Martha's Vineyard. Along the inshore edge of its range, little skate moves onshore and offshore seasonally. They generally move into shallow water during the spring and into deeper water in the winter and may leave some estuaries for deeper water during warmer months.

Adults. EFH for adult little skate has been designated for the areas of highest relative abundance for this species based on NMFS trawl survey (1963-1999) and ELMR data. Only habitats with sandy, gravelly, or mud substrates that occur within these areas of high abundance are designated as EFH (Packer et al., 2003b).

NEFSC bottom trawl surveys (Reid et al., 1999) captured adult little skate during all seasons. The numbers of adults in spring and fall were much lower than for juveniles of the same two seasons. In winter, they were caught from Georges Bank to North Carolina, with very few in the Gulf of Maine. In spring they were also found from Georges Bank to North Carolina and, as with the juveniles, were also distributed nearshore throughout the Mid-Atlantic Bight and along Long Island as well as in Cape Cod and Massachusetts Bays. They had a limited distribution in the summer, being found mostly in southern New England, Georges Bank, Cape Cod Bay, in the Gulf of Maine near Penobscot Bay, and near Browns

Bank and the Northeast Channel. The distributions of adult little skate from both the spring and fall Massachusetts inshore trawl surveys (Reid et al., 1999) were similar to that of the juveniles, but with fewer numbers collected in all areas (including west and south of Martha's Vineyard).

Forage species. In general, little skate feed on benthic fishes and invertebrates (i.e., associated with the bottom) (Collette and Klein-MacPhee, 2002). Little skate from the Woods Hole region were found to contain mostly crabs, followed by sand shrimp (*Crangon septemspinosa*) and squid (Packer et al., 2003a), although overall the most important prey items for the species are decapod crustaceans (crabs) and amphipods followed by polychaetes (Bowman et al., 2000). Razor clams are also frequently taken (Ross, 1991). Fish prey include sand lance, alewives, herring, cunners, silversides, tomcod, and silver hake (Packer et al., 2003a), as well as sculpins and yellowtail flounder (Collette and Klein-MacPhee, 2002).

**Winter skate *(Leucoraja ocellata)***

Juveniles. EFH for juvenile winter skate has been designated for the areas of highest relative abundance for this species based on NMFS trawl survey (1963 to 1999) and ELMR data. Only habitats with a substrate of sand and gravel or mud that occur within these areas of high abundance are designated as EFH (Packer et al., 2003b).

NEFSC bottom trawl surveys conducted between 1963 and 2002 (Reid et al., 1999) captured juvenile winter skate year-round. In winter, juveniles were found from Georges Bank to Cape Hatteras, out to the 200 m (656 ft) depth contour, but were almost entirely absent from the Gulf of Maine. In spring they were also found from Georges Bank to Cape Hatteras, and were concentrated nearshore throughout the Mid-Atlantic Bight and southern New England as well as in Cape Cod and Massachusetts Bays. Comparatively few were present in summer, with concentrations on Georges Bank and around Cape Cod. Winter skate abundances in the fall were not as high as in the spring. In the fall they were collected from Georges Bank to the Delmarva Peninsula and were again concentrated along Long Island, southern New England, around Cape Cod, and on Georges Bank. Both the spring and fall 1978-2002 Massachusetts inshore trawl surveys (Reid et al., 1999) show similar abundances and distributions of juveniles. The highest concentrations were found on the Atlantic side of Cape Cod and south and west of Martha's Vineyard (especially in spring) and south and northeast of Nantucket (also in spring). Large numbers were also found near Monomoy Point in the fall. Other notable occurrences of winter skate were around Plum Island, Ipswich Bay, north of Cape Ann, near Nahant Bay (especially in the fall), in Cape Cod Bay, and in Nantucket Sound.

Adults. EFH for adult winter skate has been designated for the areas of highest relative abundance for this species based on NMFS trawl survey (1963 to 1999) and ELMR data. Only habitats with a substrate of sand and gravel or mud that occur within these areas of high abundance are designated as EFH (Packer et al., 2003b).

NEFSC bottom trawl surveys (Reid et al., 1999) captured adult winter skate during all seasons. The numbers of adults in spring and fall were much lower than for juveniles of the same two seasons. In winter, adult winter skate were scattered from Georges Bank to North Carolina; very few occurred in the Gulf of Maine. In the spring, they were also found from Georges Bank to North Carolina but, as with the juveniles, were also distributed nearshore throughout the Mid-Atlantic Bight and along Long Island as well as around Cape Cod and Massachusetts Bays. Few occurred in summer, being found mostly on Georges Bank, Nantucket Shoals, and near Cape Cod. In the fall, they were mostly confined to Georges Bank, near Nantucket shoals, and near Cape Cod, with very few found south of those areas. Adult little skate were collected in much fewer numbers than juveniles during the spring and fall Massachusetts inshore trawl surveys. The greatest numbers were found on the Atlantic side of Cape Cod and, in spring, south of Nantucket.

Forage species. In general, winter skate prey on fishes and invertebrates that are associated with the bottom. Prey include hydrozoans, gastropods, bivalves, squids, polychaetes, cumaceans, isopods, amphipods, mysids, euphausiids, pandalid shrimps, crangon shrimps, hermit crabs, cancer crabs, portunid crabs, rock crabs, razor clams, echinoderms, and fishes (Bowman et al., 2000; Ross, 1991). Out of the above prey mentioned, amphipods and polychaetes are the most common forage but fishes, decapod crustaceans, isopods, bivalves, and hydroids are also important (Packer et al., 2003b). Studies show that smaller individuals consume relatively more amphipods and cumaceans and larger specimens consume relatively more decapods, polychaetes and fishes (Collette and Klein-MacPhee, 2002). In general, fishes make up the majority of the diet of individuals larger than 7.8 inches (20 cm) (Bowman et al., 2000). Fish prey include skates, herring, alewife, blueback herring, menhaden, silver hake, red hake, tomcod, cod, smelts, sculpins, sand lance, cunner, butterfish, and summer and yellowtail flounders (Collette and Klein-MacPhee, 2002).

#### 4.2.8.2.7 Invertebrates

**Long-finned squid *(Loligo pealei)***

Juveniles, or "Pre-recruits." EFH for long-finned squid pre-recruits consists of those pelagic waters over the continental shelf from the Gulf of Maine to Cape Hatteras. Older juveniles (sub-adults) are thought to overwinter in deeper waters along the edge of the continental shelf (Black et al., 1987). They were also collected in greater abundance during the fall than in spring, with concentrations in Buzzards Bay, around Martha's Vineyard and Nantucket Island, throughout Cape Cod Bay, in Massachusetts Bay, and north and south of Cape Ann. The spring concentrations occurred in Buzzards Bay and around Martha's Vineyard and Nantucket Island (Jacobson, 2005). Lower numbers of the pre-recruits in the inshore waters in spring was likely due to surveys taking place before the main part of the inshore migration (Jacobson, 2005).

Adults, or "Recruits." Adult long-finned squid also have EFH designated as the pelagic waters over the continental shelf from the Gulf of Maine to Cape Hatteras. Adults will migrate offshore during late fall and overwinter in warmer waters along the edge of the continental shelf, returning inshore during the spring and early summer (MAFMC, 1996b). Off Massachusetts, larger individuals migrate inshore in April-May to begin spawning, while smaller individuals move inshore during the summer (Lange, 1982). MassDMF (2001b) survey trawls on Horseshoe Shoal have found long-finned squid are abundant year round within the proposed action area.

Forage species. In general the diet of the long-finned squid changes with size; small immature individuals feed on planktonic organisms and polychaete worms, whereas larger individuals feed on small fish and crustaceans such as euphausiids (krill), small crabs and shrimp. (Cargnelli et al., 1999b). In addition, studies (Cargnelli et al., 1999b) stated that cannibalism is observed in individuals larger than 5 cm. Fish species preyed on by long-finned squid include silver hake, mackerel, herring, menhaden, sand lance, bay anchovy, menhaden, weakfish, and silversides (Cargnelli et al., 1999b).

**Short-finned squid *(Illex illecebrosus)***

Juveniles, or "Pre-recruits." EFH for juvenile short-finned squid is designated as those pelagic waters over the continental shelf from the Gulf of Maine to Cape Hatteras. Studies in Cargnelli et al. (1999a) state short-finned squid are highly migratory, moving offshore in the fall and not returning to the continental shelf until the following spring. The migratory paths during this time have not been thoroughly researched. In NEFSC Massachusetts surveys (Cargnelli et al., 1999a), very few juveniles were taken during the spring north of Nantucket, while only few were taken in the fall west of Nantucket and east of Cape Cod. Short-finned squid exist mainly in deeper waters, and are not particularly common within the proposed action area.

Adults, or "Recruits." For adult short-finned squid, EFH also exists in the pelagic waters over the continental shelf from the Gulf of Maine to Cape Hatteras. Studies in (Cargnelli et al., 1999a) state short-finned squid are highly migratory, moving offshore in the fall and not returning to the continental shelf until the following spring. The migratory paths during this time have not been thoroughly researched. In NEFSC Massachusetts surveys (Cargnelli et al., 1999a), as with the juvenile population, very few adults were taken during the spring in the coastal waters of Massachusetts, while more were taken in the fall west of Nantucket and east of Cape Cod. The distribution was found to correlate well with the species' inshore-offshore migrations (Cargnelli et al., 1999a). In general, there are more adults present in the spring than juveniles due to size-related differences in the timing of migration (i.e., larger individuals migrate inshore earlier in the spring) (Cargnelli et al., 1999a). Short-finned squid exist mainly in deeper waters and are not particularly common within the proposed action area.

Forage species. Northern shortfin squid feed primarily on fish, squid and crustaceans. Fish prey include the early life history stages of Atlantic cod, sand lance, mackerel, Atlantic herring, sculpin, and mummichogs as well as longfin inshore squid, cannibalism is also significant among this species (Hendrickson and Holmes, 2004). Studies in (Hendrickson and Holmes, 2004) also state that when the shortfin squid are inshore in the summer and fall they primarily consume fish and squid.

**Surf clam *(Spisula solidissima)***

Juveniles and Adults. Because of the wide variability in age at maturity, juvenile and adult surf clams are discussed together (Cargnelli et al., 1999c). EFH for both life stages exists within the substrate to a depth of 3.3 ft (1 m) below the water/sediment interface, from the Gulf of Maine and eastern Georges Bank throughout the Atlantic EEZ. Studies reviewed in Cargnelli et al. (1999c) have shown the greatest concentration of surf clams are usually found in well-sorted, medium-grained sand, and are most common at depths of 26.2 to 216.5 ft (8 to 66 m) in the turbulent areas beyond the breaker zone.

Forage species. In general, Atlantic surf clams are planktivorous siphon feeders (Cargnelli et al., 1999c). Studies in (Cargnelli et al., 1999c) noted the presence of many genera and species of diatoms (a unicellular organism) in the guts of Atlantic surf clams although ciliates (unicellular free-living protists) were also found to be a common component of their diet (Cargnelli et al., 1999c).

### *4.2.8.3 Landings Data for EFH Species*

Both NOAA Fisheries and MassDMF monitor certain commercial and recreational fishing activities within Nantucket Sound. NOAA Fisheries monitors federally-permitted commercial and recreational fishing activities in all coastal states throughout the United States. The Commonwealth of Massachusetts monitors state-permitted commercial fishing activities in its coastal waters for certain fisheries and gear types. In addition, a valuable source of resource data available for Nantucket Sound is the MassDMF independent fisheries monitoring program. For more details on these datasets, please see Report No. 4.2.7-1 and Report No. 4.2.5-5. Using these agency database sources, the following were reviewed to determine the occurrence and relative reported landings of species with designated EFH in Nantucket Sound:

- Commercial catch data monitored by NOAA Fisheries and reported on NOAA VTRs by federally-permitted vessels fishing in Nantucket Sound
- Commercial catch data monitored by MassDMF and reported by state-permitted vessels fishing in Nantucket Sound
- Recreational fishery information obtained from the NOAA Fisheries MRFSS for three counties surrounding Nantucket Sound (Dukes, Nantucket, and Barnstable)

- Recreational catch data reported by federally-permitted charter or party boats fishing in Nantucket Sound
- MassDMF bi-annual resource trawls for Nantucket Sound (information gathered is for state resource assessment and management purposes and is independent of commercial fisheries activities)

A summary table listing which databases reported the presence of the EFH designated species is provided in Table 4.2.8-2. The detailed reported landings and catch data for these species according to the NOAA and MassDMF databases are summarized below.

**Atlantic cod**

This species was documented by the NOAA VTR commercial landings database, NOAA Fisheries MRFSS database, MassDMF commercial database, and the MassDMF resource trawl spring and fall survey database.

- During the eleven years of NOAA commercial VTR data landings (1994-2004), cod was reported in six of the years with a total of 2,865 lb (1,299.5 kg) harvested from Nantucket Sound.
- The numbers of Atlantic cod observed by MRFSS survey interviewers from 1990-2004 in three counties surrounding Nantucket Sound were: 278 from party/charter boats and 38 from private/rental boats.
- During the eleven years of MassDMF commercial data landings (1994-2004), gill nets were fished in Nantucket Sound only five of the years. Cod was reported in three of five of the years with a total of 3,346 lb (1,517.7 kg) harvested from the Sound.
- During the 27 years of MassDMF fall data and 26 years of spring data in Nantucket Sound, Atlantic cod was reported in one year in the fall with a total of 6 individuals caught and in every year in the spring with a total of 4,768 individuals caught.

**Scup**

This species was documented by the NOAA VTR commercial and recreational charter landings databases, NOAA MRFSS database, MassDMF commercial database, and the MassDMF resource trawl spring and fall survey database.

- During the eleven years of NOAA commercial VTR data landings (1994-2004), scup was reported every year with a total of 564,380 lb (564,380 kg) harvested from Nantucket Sound.
- During the eleven years of NOAA recreational charter VTR data landings (1994-2004), scup was reported every year with a total of 508,129 individuals harvested from Nantucket Sound.
- The numbers of scup observed by MRFSS survey interviewers from 1990-2004 in three counties surrounding Nantucket Sound were: 192 from shore, 2,472 from party/charter boats and 566 from private/rental boats.
- During the fifteen years of MassDMF commercial data landings for fish weirs (1990-2004), scup was reported every year with a total of 1,583,567 lb (718,293.9 kg) harvested from Nantucket Sound. Scup was also reported in the eleven years of fish

pots landings (1994-2004) with a total of 1,307,897 lb (593,250 kg) harvested from Nantucket Sound.

- During the 27 years of MassDMF fall data and 26 years of spring data in Nantucket Sound, scup was reported in every year in the fall with a total of 1,559,537 individuals caught and in every year in the spring with a total of 27,616 individuals caught.

**Black sea bass**

This species was documented by the NOAA VTR commercial and recreational charter landings databases, NOAA MRFSS database, MassDMF commercial database, and the MassDMF resource trawl spring and fall survey database.

- During the eleven years of NOAA commercial VTR data landings (1994-2004), black sea bass was reported every year with a total of 736,861 lb (334,235.5 kg) harvested from Nantucket Sound.
- During the eleven years of NOAA recreational charter VTR data landings (1994-2004), black sea bass was reported every year with a total of 58,871 individuals harvested from Nantucket Sound.
- The numbers of black sea bass observed by MRFSS survey interviewers from 1990-2004 in three counties surrounding Nantucket Sound were: 10 from shore, 186 from party/charter boats and 102 from private/rental boats.
- During the fifteen years of MassDMF commercial data landings for fish weirs and fish pots (1990-2004), black sea bass was reported in four of the years with a total of 63,929 lb (28,997.7 kg) harvested from Nantucket Sound and in every year with a total of 2,837,308 lb (1,286,981.3 kg) harvested from Nantucket Sound, respectfully.
- During the 27 years of MassDMF fall data and 26 years of spring data in Nantucket Sound, black sea bass was reported in every year in the fall with a total of 64,950 individuals caught and in 25 of the years in the spring with a total of 891 individuals caught.

**Winter flounder**

This species was documented by the NOAA VTR commercial and recreational charter landings databases, NOAA MRFSS database, MassDMF commercial database, and the MassDMF resource trawl spring and fall survey database.

- During the eleven years of NOAA commercial VTR data landings (1994-2004), winter flounder was reported every year with a total of 77,961 lb (35,362.5 kg) harvested from Nantucket Sound.
- During the eleven years of NOAA recreational charter VTR data landings (1994-2004), winter flounder was reported in eight of the years with a total of 169 individuals harvested from Nantucket Sound. An additional 5 lb of unspecified flounder was harvested in 1995.
- The numbers of winter flounder observed by MRFSS survey interviewers from 1990-2004 in three counties surrounding Nantucket Sound were: 87 from shore, 38 from party/charter boats and 415 from private/rental boats.

- During the fifteen years of MassDMF commercial data landings for fish weirs (1990-2004), winter flounder was reported in four of the years with a total of 2,093 lb (949.4 kg) harvested from Nantucket Sound. An additional 376 lb (170.5 kg) of unclassified flounder was harvested from the Sound using fish weirs. Gill nets were fished in only five out of eleven years (1994-2004) according to MassDMF commercial data landings. Winter flounder was reported in three of the five years with a total of 2,549 lb (1156.2 kg) harvested and an additional 43 lb (19.5 kg) of unclassified flounder harvested from gill nets in Nantucket Sound.
- During the 27 years of MassDMF fall data and 26 years of spring data in Nantucket Sound, Atlantic cod was reported in 26 of the years in the fall with a total of 1,094 individuals caught and in every year in the spring with a total of 13,451 individuals caught.

**Summer flounder**

This species was documented by the NOAA VTR commercial and recreational charter landings databases, NOAA MRFSS database, MF commercial database, and the MassDMF resource trawl spring and fall survey database.

- During the eleven years of NOAA commercial VTR data landings (1994-2004), summer flounder was reported every year with a total of 912,017 lb (413,683.9 kg) harvested from Nantucket Sound.
- During the eleven years of NOAA recreational charter VTR data landings (1994-2004), summer flounder was reported every year with a total of 6,036 individuals harvested from Nantucket Sound.
- The numbers of summer flounder observed by MRFSS survey interviewers from 1990-2004 in three counties surrounding Nantucket Sound were: 63 from shore, 60 from party/charter boats and 664 from private/rental boats.
- During the fifteen years of MassDMF commercial data landings for fish weirs (1990-2004), summer flounder was reported in every year with a total of 54,311 lb (24,635 kg) harvested from Nantucket Sound. Gill nets were fished in only five out of eleven years (1994-2004) according to MassDMF commercial data landings. Summer flounder was reported in three of the five years with a total of only 112 lb (50.8 kg) harvested from gill nets in Nantucket Sound.
- During the 27 years of MassDMF fall data and 26 years of spring data in Nantucket Sound, summer flounder was reported in every year in the fall and spring with a total of 1,509 individuals and 846 individuals caught, respectively.

**Windowpane**

This species was documented by the NOAA VTR commercial landings database, NOAA MRFSS database, MassDMF commercial database, and the MassDMF resource trawl spring and fall survey database.

- During the eleven years of NOAA commercial VTR data landings (1994-2004), windowpane was reported in seven of the years with a total of 2,981 lb (1,352.2 kg) harvested from Nantucket Sound.

- The numbers of windowpane observed by MRFSS survey interviewers from 1990-2004 in three counties surrounding Nantucket Sound were: 31 from shore and three from private/rental boats.
- During the 27 years of MassDMF fall data and 26 years of spring data in Nantucket Sound, windowpane was reported in every year in the fall and spring with a total of 655 individuals and 18,768 individuals caught, respectively.

**Yellowtail flounder**

This species was documented by the NOAA VTR commercial landings database, NOAA MRFSS database, MassDMF commercial database, and the MassDMF resource trawl spring survey database.

- During the eleven years of NOAA commercial VTR data landings (1994-2004), yellowtail flounder was reported in four of the years with a total of 2,981 lb (1,352.2 kg) harvested from Nantucket Sound.
- The numbers of yellowtail flounder observed by MRFSS survey interviewers from 1990-2004 in three counties surrounding Nantucket Sound were: 1 from shore and 2 from private/rental boats.
- During the eleven years of MassDMF commercial data landings (1994-2004), gill nets were fished in only five of the years. Yellowtail flounder was reported in three of the five years with a total of 3,862 lb (1751.8 kg) harvested from gill nets in the Sound.
- During the 26 years of MassDMF spring data in Nantucket Sound, yellowtail flounder was reported in nine of the years with a total of only 14 individuals caught. Yellowtail founder was not reported in any of MassDMF fall resource trawl data in Nantucket Sound over the 27 year period.

**Atlantic butterfish**

This species was documented by the NOAA VTR commercial and recreational charter landings databases, NOAA MRFSS database, MassDMF commercial database, and the MassDMF resource trawl spring and fall survey database.

- During the eleven years of NOAA commercial VTR data landings (1994-2004), Atlantic butterfish was reported in nine of the years with a total of 70,034 lb (31,766.9 kg) harvested from Nantucket Sound.
- During the eleven years of NOAA recreational charter VTR data landings (1994-2004), Atlantic butterfish was reported in two of the years with a total of 2 individuals harvested from Nantucket Sound.
- The numbers of Atlantic butterfish observed by MRFSS survey interviewers from 1990-2004 in three counties surrounding Nantucket Sound were: 9 from shore.
- During the fifteen years of MassDMF commercial data landings for fish weirs (1990-2004), Atlantic butterfish were reported in every year with a total of 191,814 lb (87,005.4 kg) harvested from Nantucket Sound.
- During the 27 years of MassDMF fall data and 26 years of spring data in Nantucket Sound, Atlantic butterfish was reported in every year in the fall with a total of

217,038 individuals caught and in 24 of the years in the spring with a total of 6,579 individuals caught.

**Atlantic mackerel**

This species was documented by the NOAA VTR commercial and recreational charter landings databases, NOAA MRFSS database, MassDMF commercial database, and the MassDMF resource trawl spring survey database.

- During the eleven years of NOAA commercial VTR data landings (1994-2004), Atlantic mackerel was reported in eight of the years with a total of 1,269,104 lb (575,655.9 kg) harvested from Nantucket Sound.
- During the eleven years of NOAA recreational charter VTR data landings (1994-2004), Atlantic mackerel was reported in two of the years with a total of 2 individuals harvested from Nantucket Sound.
- The numbers of Atlantic mackerel observed by MRFSS survey interviewers from 1990-2004 in three counties surrounding Nantucket Sound were: 453 from shore, 25 from party/charter boats and 1 from private/rental boats.
- During the fifteen years of MassDMF commercial data landings for fish weirs (1990-2004), Atlantic mackerel were reported in every year with a total of 5,785,313 lb (2,624,173.8 kg) harvested from Nantucket Sound. Gill nets were fished in only five out of eleven years (1994-2004) according to MassDMF commercial data landings. Atlantic mackerel was reported in three of the five years with a total of 6,305 lb (2,859.9 kg) harvested from Nantucket Sound.
- During the 26 years of MassDMF spring data in Nantucket Sound, Atlantic mackerel was reported in 10 of the years in the spring with a total of 68 individuals caught. Atlantic mackerel was not reported in any of MassDMF fall resource trawl data in Nantucket Sound over the 27 year period.

**King mackerel**

This species was documented by the MassDMF commercial database only.

- During the fifteen years of MassDMF commercial data landings for fish weirs (1990-2004), king mackerel was reported in twelve of the years with a total of 4,910 lb (2,227.1 kg) harvested from Nantucket Sound. King mackerel was not reported in MassDMF commercial data landings for any other fishery or gear type in Nantucket Sound.

**Spanish mackerel**

This species was documented by the NOAA VTR commercial and recreational charter landings databases, NOAA MRFSS database, and the MassDMF commercial database.

- During the eleven years of NOAA commercial VTR data landings (1994-2004), Spanish mackerel was reported in one of the years with a total of only 4 lb (1.8 kg) harvested in Nantucket Sound.
- During the eleven years of NOAA recreational charter VTR data landings (1994-2004), Spanish mackerel was reported in one of the years with a total of only 1 individual harvested in Nantucket Sound.

- The numbers of Spanish mackerel observed by MRFSS survey interviewers from 1990-2004 in three counties surrounding Nantucket Sound were: 5 from shore and 1 from private/rental boats.
- During the fifteen years of MassDMF commercial data landings for fish weirs (1990-2004), Spanish mackerel was reported in fourteen of the years with a total of 67,687 lb (30,702.3 kg) harvested from Nantucket Sound.

**Cobia**

This species was not reported in any of the five databases.

**Blue shark**

This species was not reported in any of the five databases. The MFRSS survey reported shark, but it was not classified to the species level.

**Shortfin mako shark**

This species was documented by the NOAA MRFSS database only.

- The numbers of shortfin mako shark observed by MRFSS survey interviewers from 1990-2004 in three counties surrounding Nantucket Sound were: 1 from party/charter boats and 1 from private/rental boats.

**Bluefin tuna**

This species was documented by the NOAA VTR commercial landings database and the NOAA MRFSS database.

- During the eleven years of NOAA commercial VTR data landings (1994-2004), bluefin tuna was reported in only one of the years with a total of 375 lb (170 kg) harvested from Nantucket Sound.
- The numbers of bluefin tuna observed by MRFSS survey interviewers from 1990-2004 in three counties surrounding Nantucket Sound were: 16 from private/rental boats.

**Little skate**

The NOAA VTR commercial and recreational charter landings databases and the MassDMF commercial database reported landings for unspecified skate species. The NOAA MRFSS database and the MassDMF resource trawl spring and fall survey database reported landings specifically for little skate.

- During the eleven years of NOAA commercial VTR data landings (1994-2004), unspecified skate species was reported in ten of the years with a total of 12,792 lb (5,802.3 kg) harvested from Nantucket Sound.
- During the eleven years of NOAA recreational charter VTR data landings (1994-2004), unspecified skate species was reported in ten of the years with a total of 174 individuals harvested from Nantucket Sound.
- The numbers of little skates observed by MRFSS survey interviewers from 1990-2004 in three counties surrounding Nantucket Sound were: 4 from private/rental boats. In addition, one unspecified skate was observed from private/rental boats.

- During the eleven years of MassDMF commercial data landings (1994-2004), gill nets were fished in only five of the years. Unclassified skates were reported in one of the five years with a total of 371 lb (168.3 kg) harvested from Nantucket Sound.
- During the 27 years of MassDMF fall data and 26 years of spring data in Nantucket Sound, little skate was reported in every year in the fall and spring with a total of 6,534 individuals and 6,794 individuals caught, respectively.

**Winter skate**

The NOAA VTR commercial and recreational charter landings databases and the MassDMF commercial database reported landings for unspecified skate species. The NOAA MRFSS database and the MassDMF resource trawl spring and fall survey database reported landings specifically for winter skate.

- For NOAA commercial VTR data and recreational charter VTR data landings, see above.
- The numbers of winter skate observed by MRFSS survey interviewers from 1990-2004 in three counties surrounding Nantucket Sound were: 1 from private/rental boats.
- During the 27 years of MassDMF fall data and 26 years of spring data in Nantucket Sound, winter skate was reported in every year in the fall and spring with a total of 4,205 individuals and 5,481 individuals caught, respectively.

**Long-finned squid**

This species was documented by the NOAA VTR commercial and recreational charter landings databases, MassDMF commercial database (not specific to species), and the MassDMF resource trawl spring and fall survey database.

- During the eleven years of NOAA commercial VTR data landings (1994-2004), long-finned squid was reported in every year with a total of 3,583,134 lb (1,625,282.2 kg) harvested from Nantucket Sound. An additional 169,825 lb (77,031.3 kg) of unspecified squid was harvested from Nantucket Sound.
- During the eleven years of NOAA recreational charter VTR data landings (1994-2004), long-finned squid was reported in seven of the years with a total of 19,680 individuals harvested from Nantucket Sound. An additional 1,031 lb (467.7 kg) of unspecified squid was harvested from Nantucket Sound.
- During the fifteen years of MassDMF commercial data landings for fish weirs (1990-2004), unclassified squid were reported in every year with a total of 4,726,815 lb (2,144,047.2 kg) harvested from Nantucket Sound.
- During the 27 years of MassDMF fall data and 26 years of spring data in Nantucket Sound, long-finned squid was reported in every year in the fall and spring with a total of 228,817 individuals and 54,408 individuals caught, respectively.

**Short-finned squid**

This species was documented by the NOAA VTR commercial and recreational charter landings databases, MassDMF commercial database (not specific to species), and the MassDMF resource trawl spring survey database.

- During the eleven years of NOAA commercial VTR data landings (1994-2004), short-finned squid was reported in six of the years with a total of 79,152 lb (35,902.7 kg) harvested from Nantucket Sound.
- During the eleven years of NOAA recreational charter VTR data landings (1994-2004), short-finned squid was reported in one of the years with a total of 500 individuals harvested from Nantucket Sound.
- During the 26 years of MassDMF spring data in Nantucket Sound, short-finned squid was reported in one of the years with a total of 1 caught in the spring. Short-finned squid was not reported in any of MassDMF fall resource trawl data in Nantucket Sound over the 27 year period.

**Surf clam**

This species was documented by the NOAA VTR commercial landings database (not specific to species), MassDMF commercial database, and the MassDMF resource trawl spring and fall survey database.

- During the eleven years of NOAA commercial VTR data landings (1994-2004), an unspecified clam species was reported in two of the years with a total of 137,936 lb (62,566.7 kg) harvested from Nantucket Sound.
- During the fifteen years of MassDMF commercial data landings for fish pots (1990-2004), surf clam was reported in six of the years with a total of 12,816,980 lb (5,813,684.3 kg) harvested from Nantucket Sound.
- During the 27 years of MassDMF fall data and 26 years of spring data in Nantucket Sound, surf clam was reported in thirteen of the years in the fall with a total of 61 individuals caught and in eight of the years in the spring with a total of 17 individuals caught.

### 4.2.9 Threatened and Endangered (T&E) Species

#### *4.2.9.1 Introduction*

This section provides an overview of the species in the area of the proposed action that are protected under the Endangered Species Act (ESA). More detailed information on the presence of federally-listed species in the area of the proposed action and potential impacts to these species from the proposed action is included in the Biological Assessment (BA) in Appendix G. The MMS, as the lead federal NEPA agency for the proposed action, is mandated by Section 7 of the ESA to consult with the Department of Commerce (via NOAA Fisheries Service) and the Secretary of the Interior (via U.S. Fish & Wildlife Service [FWS]) to determine if any species protected under the ESA may be affected by the proposed action. MMS submitted a BA to these agencies in May 2008 to initiate formal consultation which includes the evaluation of potential impacts from the proposed action on listed species and designated critical habitat. The outcome of these consultations and reviews, in the form of a Biological Opinion, assesses whether the action is likely to "...jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of the critical habitat of such species" (50 CFR Part 402). Where possible, requirements and recommendations would be provided within these

Biological Opinions as to how the potential for impacts from the proposed action can be minimized or eliminated. Further, an Incidental Take Statement (ITS) may be given, allowing the unintentional "taking' of listed species based on certain conditions.

### *4.2.9.2 Studies Completed*

Review of scientific literature, including stock assessment reports, and consultation with resource management agencies, suggest that few studies of marine mammal and turtle species have been conducted within Nantucket Sound. A literature search targeting threatened and endangered whale, and reptile species in Nantucket Sound and acoustical impacts to marine mammals and reptiles was conducted to obtain information on marine species in Nantucket Sound and potential impacts of the proposed action to these resources. In addition, researchers from the Protected Resources Branch at the NMFS Northeast Fisheries Science Center, the Sea Turtle Stranding and Salvage Network, the Provincetown Center for Coastal Studies, and the University of Rhode Island, were contacted by the applicant to obtain additional stock assessment, sighting, stranding, and population studies information. MMS has also worked with the staff at NOAA Fisheries during development of this EIS and the associated BA.

In addition, a similar approach to gathering data was followed in order to characterize those protected species under the jurisdiction of the FWS, including three bird species, a beetle, and a rabbit species. Of these five species, three are listed as threatened or endangered under the ESA (roseate tern [*Sterna dougallii*], piping plover [*Charadrius melodus*] and northeastern beach tiger beetle [*Cicindela dorsalis dorsalis*]) and two as candidate species (red knot [*Calidris canutus rufa*] and New England cottontail [*Sylvilagus transitionalis*]). In its formal consultation request to the USFWS, MMS requested consultation for the roseate tern and piping plover since they are species listed as threatened or endangered with the potential to occur in the project area. In addition, as part of the formal consultation process, the FWS updated its list of threatened or endangered species that may occur in the area of the proposed action. In a FWS letter to MMS, dated September 30, 2008 (in Appendix B), the northeastern beach tiger beetle (*Cicindela dorsalis dorsalis*) was identified as being on the periphery of the project area with the potential to be adversely affected in the event of an oil spill attributable to the proposed action. MMS was requested to amend its BA to include an independent analysis and effects determination. The MMS BA amendment letter is included in Appendix G, and information on this beetle has been added to the FEIS. This EIS also contains an analysis on the two candidate species in order to assess the potential for impacts and, where appropriate, determine if measures are needed to minimize or eliminate such impacts.

The applicant also conducted extensive studies of the avifauna, and Massachusetts Audubon Society also performed studies, only some of which relate to listed bird species. The information gathered during this research is the best available scientific and commercial information and is used to determine the potential impacts of the proposed action in Section 5.3.2.6.

### *4.2.9.3 Resource Characterization*

While initial FWS letters indicated there are no federally-listed or proposed threatened or endangered species located within the proposed onshore transmission cable system route to the Barnstable Switching Station, with the exception of the occasional transient bald eagle (*Haliaeetus leucocephalus*) (Appendix G), their September 30, 2008 letter (Appendix B) identified the threatened northeastern beach tiger beetle (*Cicindela dorsalis dorsalis*) as potentially occurring on beaches in the project area, therefore this species has been added to this analysis. Since the applicant filed its application for the proposed action the bald eagle has been de-listed, and is therefore not discussed in this document. There are two listed birds, the roseate tern **(***Sterna dougallii)* and the piping plover (*Charadrius melodus*) that have the potential to occur in the area of the proposed action, as well as the candidate species, the red knot

(*Calidris canutus rufa*). An additional candidate species in the proposed action area is the New England Cottontail (*Sylvilagus transitionalis*).

The proposed transmission cable landfall for the proposed action is located approximately 0.8 miles (1.3 km) from the nearest known nesting sites of piping plover on Great Island and 1.5 miles (2.4 km) from nesting sites at Kalmus Beach/Dunbar Point, Hyannis and the north-western corner of Great Island. The proposed action's buried cables (at their closest point to nesting sites) would pass within approximately 820 ft (250 m) of Kalmus Beach/Dunbar Point and approximately 1,210 ft (369 m) of Great Island. Support vessels associated with the proposed action's cable installation would pass within approximately 670 ft (204 m) of Kalmus Beach/Dunbar Point and 1,060 ft (323 m) of Great Island (Report No. 4.2.9-1).

The NOAA Fisheries consultation has led to the identification of three whales and four sea turtles as having the potential to occur in the area of the proposed action. The whale species include the humpback whale (*Megaptera novaeangliae*), the fin whale (*Balaenoptera physalus*), and the North Atlantic right whale (*Eubalaena glacialis*). Three other listed whale species, the sperm (*Physeter macrocephalus*), sei (*Balaenoptera borealis*), and blue (*Balaenoptera musculus*) do not occur in the project area, as all of these species occur in deep offshore waters. The sea turtle species include the loggerhead sea turtle (*Caretta caretta*), the Kemp's ridley sea turtle (*Lepidochelys kempi*), the leatherback sea turtle (*Dermochelys coriacea*), and the green sea turtle (*Chelonia mydas*).

A brief overview of the life history characteristics for these species is provided below, and a summary overview of the potential impacts is provided in Section 5.3.2.9. For a detailed presentation of the characteristics of the T&E species that have been identified as potentially occurring in the area of the proposed action and potential impacts associated with the project (see the BA in Appendix G). Detailed presentation of information on the red knot and the New England cottontail are provided below, and in Section 5.3.2.9, but not in the BA in Appendix G, since these are candidate species under the ESA.

**Humpback Whale (*Megaptera novaeangliae*)**

Humpback whales (*Megaptera novaeangliae*) occur throughout the world. Humpback whales are opportunistic feeders, and prey on a variety of pelagic crustaceans and small fish (Nemoto, 1970; Kreiger and Wing, 1984). There are three primary feeding aggregations in the Western Atlantic: the U.S. east coast (including the Gulf of Maine), the Gulf of St. Lawrence, Newfoundland/Labrador, and Western Greenland (Waring et al., 2006). Humpback whales are a migratory species, feeding in the northern latitudes during the summer months and migrating to the West Indies during winter months to mate and calve (Waring et al., 2006). Humpback whales regularly visit the area of southern New England, where they are present in greatest abundance between June and September (Payne and Heinemann, 1990; Sadove and Cardinale, 1993). Located offshore from Nantucket Sound are primary feeding grounds for humpback whales, mainly supplying whales from the Gulf of Maine feeding aggregation. Few humpback whales are sighted within Nantucket Sound since they favor locations further north for feeding grounds, as prey species are not plentiful within the Sound (Kenney and Winn, 1986).

Humpback whales were first listed as an endangered species in the U.S. in 1970. The best estimate for humpback whales in the Gulf of Maine is 847 individuals based on surveys conducted in August 2006 from the southern Gulf of Maine to the upper Bay of Fundy to the Gulf of St. Lawrence (Waring et al., 2007). Current data suggests that the Gulf of Maine stock is increasing in size.

Between 2001 and 2005, the minimum annual rate of human-caused mortality and serious injury to the Gulf of Maine humpback whale stock averaged 4.2 animals per year (Waring et al., 2007). This is based on three causes: (1) incidental fishery interactions; (2) vessel collisions; and (3) direct takes (this occurred during winter breeding periods in the south) (Waring et al., 2006). The most common source of mortality for humpback whales in the western North Atlantic is entanglement in commercial fishing gear, particularly off Newfoundland (O'Hara et al., 1986; Lien et al., 1989 a, b; Hofman, 1990; Volgenau and Kraus, 1990; NMFS, 1991). The second major anthropogenic source of mortality for humpback whales in the New England is collisions with vessels. In NMFS records from 1999 to 2003, 15 humpback whales were recorded as been struck by a vessel, 6 of which resulted in mortalities.

**Fin Whale (*Balaenoptera physalus*)**

Fin whales (*Balaenoptera physalus*) are large whales found in the temperate waters of the western North Atlantic. Fin whales feed on a wide variety of small schooling fish and crustaceans, primarily capelin (Piatt et al., 1989). Fin whales range along the continental shelf between Cape Hatteras and southeastern Canada (Hain et al., 1992). Stocks of fin whales from the Gulf of Maine, Nova Scotia and Labrador are believed to be of one or a few closely related populations (Waring et al., 2006). Fin whales occur in Massachusetts waters from mid March to the end of November, in important feeding grounds of New England waters, specifically the areas around Jeffrey's Ledge, Stellwagen Bank, and Cape Cod Bay with few sightings within Nantucket Sound (NOAA Fisheries Service, 2005).

Fin whales were listed as endangered throughout their range in 1970. The best available estimates of the western North Atlantic fin whale stock is 2,269 based on surveys conducted in August 2006 from the southern Gulf of Maine to the upper Bay of Fundy to the Gulf of St. Lawrence (Waring et al., 2007).

While there is little published information about natural and anthropogenic causes of mortality in fin whales, it can be assumed that the hazards that affect humpback whales would also affect fin whales. According to NMFS records from 2001 through 2005, the minimum annual rate of human-caused mortality and serious injury to finwhales was 2.4 per year, 0.8 resulted from incidental fishing interaction and 1.6 resulted from vessel strikes (Waring et al., 2007).

**North Atlantic Right Whale (*Eubalaena glacialis*)**

The North Atlantic right whale (*Eubalaena glacialis*) is the rarest of the larger whales. The primary food of right whales in the western North Atlantic is calanoid copepods, *Calanus finmarchicus*, and juvenile euphausiids (Nemoto, 1970; Murison and Gaskin, 1989). Right whales are migratory animals, with seasonal movements including "high use" of areas from spring to fall within Cape Cod Bay, Massachusetts Bay, Georges Bank and the Gulf of Maine (Waring et al., 2006). The Great South Channel and Cape Cod Bay have been designated as critical habitat for the North Atlantic right whale, and considered to be essential for the recovery of the population (Report No. 4.2.9-2). North Atlantic right whales may occasionally occur in Nantucket Sound; however, as the waters are too shallow and not productive enough for the whale's prey, their occurrence would be considered "rare and transient."

The North Atlantic right whale has been listed as endangered under the ESA since 1973. The western North Atlantic population size was estimated to be at least 313 individuals in 2002 based on a census of individual whales identified using photo-identification techniques (Waring et al., 2007). This value is a minimum and does not include animals that were alive prior to 2002, but not recorded in the individual sightings database as seen from January 1, 2002 to June 15, 2005. It also does not include any calves known to be born during 2002, but not yet entered as new animals in the catalog.

For the period 2001 through 2005, the minimum rate of annual human-caused mortality and serious injury to right whales averaged 3.2 per year (U.S. waters, 2.0; Canadian waters, 1.2). This is derived from two components: 1) non-observed fishery entanglement records at 1.4 per year (U.S. waters, 0.4; Canadian waters, 1.0), and 2) ship strike records at 1.8 per year (U.S. waters, 1.6; Canadian waters, 0.2) (Waring et al. 2007). Researchers believe that North Atlantic right whales are more susceptible to strikes due to the characteristics of slow swimming, feeding at the surface, and preferring nearshore waters. Entanglement in fishing gear is the second leading cause of mortality in North Atlantic right whales; over half of the photographed population has some scaring from fishing gear entanglements (Waring et al., 2006).

### Loggerhead Turtle (*Caretta caretta*)

The loggerhead sea turtle (*Caretta caretta*) is a turtle that seasonably inhabits the inshore coastal waters of the North Atlantic. Adult loggerheads are primarily bottom feeders, foraging in coastal waters for benthic mollusks and crustaceans (Bjorndal, 1985). The range of the loggerhead sea turtle extends from Newfoundland to Argentina. Loggerhead turtles are abundant in the northeast from May 1 through November 15 when water temperatures are favorable (NOAA, 2005). During the spring and summer months, loggerhead turtles are commonly found in the waters off New York, with a small number of individuals, mostly comprised of juveniles, reaching as far north as New England (NOAA, 2005). There have been no direct surveys of loggerhead turtles along the North Atlantic Coast, the best available estimates for the proposed action area can be obtained through incidental observation of sea turtles made by the MAS from 2002 through 2004 during boat tern surveys. During this survey in the waters of Nantucket Sound, 115 individuals were recorded, identified as leatherback, non-leatherback and unidentifiable, of which only 14 were located within the proposed action area and 10 identified as non-leatherback or unidentifiable (MAS, 2005). The loggerhead sea turtle was listed as threatened under the ESA throughout its range in 1978, and its status has not changed.

While the causes of loggerhead sea turtle strandings, whether human-caused or natural, are not well understood, between four and seven strandings per year have been recorded in the waters Massachusetts and Rhode Island from 1990 to 2000, and 11 loggerhead strandings were recorded on the shorelines of Nantucket and Martha's Vineyard from 1980 through 1997 (NMFS, 2002 unpublished data). Strandings occur most frequently in the fall and winter, presumably caused by cold stunning due to prolonged exposure to lower water temperatures (Morreale et al., 1992; Matassa et al., 1994). Human-caused mortality of loggerhead turtles includes incidental take, fishing gear and marine debris entanglement and ingestion, and loss of nesting habitat (NOAA, 2005).

### Kemp's Ridley Turtle (*Lepidochelys kempii*)

The Kemp's ridley sea turtle (*Lepidochelys kempii*) is distributed through coastal areas of the Gulf of Mexico and northwestern Atlantic Ocean. Juveniles, representing the greatest proportion of Kemp's ridley sea turtles in the North Atlantic forage in shallow coastal waters, usually in waters less than 3 ft (1 m) deep (Ogren, 1989), but tend to move into deeper water as they grow. Young Kimp's ridley sea turtles consume several species of crabs, and crustaceans represent more than 80 percent of their diet (Burke et al., 1994). Adult Kemp's ridley sea turtles are found mainly in the Gulf of Mexico, while juveniles use northeast and mid-Atlantic coastal waters during the summer months as primary developmental habitat. Kemp's ridley turtles feed in the shallow nearshore waters of Vineyard Sound and Buzzards Bay in summer months, and may be present in the vicinity of Nantucket Sound through the fall (Burke et al., 1989; Morreale and Standora, 1989; Keniath et al., 1987; Musick and Limpus, 1997). The Kemp's ridley sea turtle was listed as endangered under the ESA in 1970.

For the period of 1990 to 2000, between nine and 216 Kemp's ridley sea turtle strandings were reported in Massachusetts waters, and one Kemp's ridley sea turtle stranding was reported in Rhode Island waters (Sea Turtle Stranding and Salvage Network, unpublished data). Each year between November and January when ocean water temperatures are falling, small numbers of Kemp's ridley sea turtles become stranded and die on beaches of the north and east shores of Long Island and Cape Cod Bay, due to cold stunning (NOAA, 1991; Morreale and Standora, 1992). Other human-caused mortality of Kemp's ridley sea turtles include incidental take, fishing gear and marine debris entanglement and ingestion, chemical pollution, and loss of nesting habitat (NOAA, 2005).

**Leatherback Turtle (*Dermochelys coriacea*)**

Leatherback sea turtles (*Dermochelys coriacea*) are found in temperate and tropical waters. They are common turtle along the eastern United States and the most common north of 42$^{o}$ N latitude. They are pelagic feeders preying on zooplankton; they can dive to considerable depths of at least 1000 m (Eckert et al., 1989). The seasonable 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. Leatherback sea turtles can be expected to be present in Nantucket Sound when water temperatures are favorable, from early summer through late fall. Leatherback sea turtles are more commonly reported in Massachusetts waters than other sea turtle species, and densities are likely associated with inshore concentrations of jellyfish. The leatherback sea turtle was listed as endangered throughout its range in 1970 under the ESA.

Incidental observation of sea turtles made by the MAS from 2002 to 2004 during tern surveys recorded 115 individuals in the waters of Nantucket Sound, of which only 14 were located within the proposed action area and 12 were identified as leatherback sea turtles or unidentifiable (MAS, 2005). Leatherbacks sea turtles are highly vulnerable to entanglement in fishing gear; 6,363 individual turtles were caught by U.S. Atlantic tuna and swordfish longlines from 1992 to 1999; 88 of those turtles died (NMFS-SEFSC, 2001). Human-caused mortality of leatherback sea turtles includes incidental take, fishing gear and marine debris entanglement and ingestion, and loss of habitat nesting (NOAA, 2005).

**Green Turtle (*Chelonia mydas*)**

The green sea turtle (*Chelonia mydas*) range in the continental U.S. extends from Massachusetts to Texas, the occurrence of this species north of Virginia during any month of the year is considered unusual (NOAA Fisheries, 2002; Thompson, 1988). Adult green sea turtles forage on shallow-growing algae and seagrasses (Crite, 2000). The green sea turtle was originally protected under the ESA in 1978.

Documented accounts of green sea turtles in New England are most commonly instances of reported strandings; between 1999 and 2001, nine strandings of green sea turtles were reported within Massachusetts and Rhode Island (STSSN, 2005). Strandings occur most frequently in the fall and winter, presumably caused by cold stunning due to prolonged exposure to low water temperatures below 50$^{o}$F (10$^{o}$C) (Morreale et al., 1992; Matassa et al., 1994). Human-caused mortality of green sea turtles include incidental bycatch by various fishing practices, fishing gear and marine debris entanglement and ingestion, oil spills, PCBs, and the loss of nesting habitat (Thompson, 1988; NMFS & USFWS, 1991; NOAA, 2005).

**Roseate Tern (*Sterna dougallii*)**

Federally-endangered roseate terns (*Sterna dougallii*) breed at limited colony locations within Buzzards Bay including Bird, Ram, and Penikese Islands; and South Monomoy and Minimoy Island in Nantucket Sound. Roseate terns return to breeding grounds in the Northeast and Atlantic Canada from late-April to mid-May. Roseate terns depart the region for their wintering grounds by September. Cape Cod, Massachusetts supports the largest pre-migratory staging habitat for roseate terns in North America and any individual from the northeastern population could occur in the area of Nantucket Sound during migration.

The majority of tern observations in Nantucket Sound during the applicant and MAS's surveys from 2002 to 2006 occurred outside of HSS. 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. Terns were observed traveling through the area of the proposed action, and few were observed actively foraging. During this period HSS likely had the lowest level of activity out of any similar habitat surveyed in the Sound.

**Piping Plover (*Charadrius melodus*)**

Federally-threatened piping plover (*Charadrius melodus*) breed along the mainland and island shores of Nantucket Sound. Piping plover spring arrival in the region peaks in late April to early May. In the fall in Massachusetts, the birds depart breeding sites by late-August. During migration periods, any individual from the Atlantic Canada or New England populations could occur in the area. Migration corridors along the coast are not well known. South Beach, Chatham and locations on Nantucket and Martha's Vineyard may provide stop-over habitat.

No piping plover were observed during either the applicant or MAS's aerial and boat surveys conducted over areas of Nantucket Sound. However, these surveys were conducted only during the day, and therefore do not account for the potential of plover crossings of the Sound at night during migration.

Beach habitat at the cable landing location is not optimal for piping plover, and the nearest known nesting beach is 1.5 miles (2.4 km) from the landfall. For the offshore portion of the proposed action area, piping plover occurrence, while not well known, is most likely less than that associated with their use of coastal beaches and shoreline areas, rather than open water areas like Horseshoe Shoal. Few crossings of Nantucket Sound are expected 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 would not result in crossings of Nantucket Sound. The exception would be occasional crossings of Nantucket Sound as individuals access alternate nesting or foraging areas. Other 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.

**Northeastern Beach Tiger Beetle (*Cicindela dorsalis dorsalis*)**

The northeastern beach tiger beetle (*Cicindela dorsalis dorsalis*) was historically common on coastal beaches from Massachusetts to central New Jersey as well as along the Chesapeake Bay in Maryland and Virginia. Only three beaches in Massachusetts contain populations of the beetle. Adult and larval beetles occur on large beaches that have little human or vehicular traffic. These beaches also consist of fine particle size sands and a high degree of exposure to tidal action.

Adult beetles measure approximately 0.6 inches in length and have a bronze green head and thorax with white or tan wing covers imprinted with fine dark lines. The larvae are pale in color with one pair of antennae and a long segmented abdomen. Adults emerge from the sand between mid-June and mid-August where they forage and mate in the intertidal zone, feeding on invertebrates and dead fish. After mating the females deposit eggs in the intertidal zone, and upon hatching, the larvae dig vertical burrows in the sand. After developing through three instars and overwintering twice, they emerge as adults.

The northeastern beach tiger beetle was federally-listed as threatened on August 7, 1990, and is also listed as a Massachusetts endangered species. Threats to this species includes degradation of habitat from human development, recreational disturbance, and pollution as well as natural factors such as beach erosion, storms, parasites, and predators.

**Red Knot (*Calidris canutus rufa*)**

The red knot (*Calidris canutus rufa*) is a medium-sized shorebird that is noted for having one of the longest migrations of any bird, and is capable of sustained flight for thousands of kilometers (Piersma, 1987). There are six subspecies, three of which occur regularly in North America; only the *C.c.rufa* population is described as "highly imperiled" in the US Shorebird Conservation Plan, and all subspecies nesting in North America are of "high concern" (USFWS, 2004; Brown et al., 2001). A decline in the number of red knot at stopover sites in the western Atlantic has been documented since the 1970's, with sharp drops observed from 1999 to 2004 (Baker et al., 2004; Morrison et al., 1994). This decline has been attributed to reduction in stopover food resources and habitat loss, in conjunction with global climate change and general human disturbances. Based on the threats to the Delaware Bay ecosystem attributed to over harvesting of horseshoe crab, coastal habitat degradation, and projected decrease in intertidal foraging habitat, the USFWS determined that *C.c.rufa* is a candidate species for listing under the ESA (1973, as amended).

***Life History***

The red knot nests in the high-central Canadian arctic and winter in austral South America, a sojourn of approximately 30,000 km (USFWS, 2006). The boreal winter is spent in Argentina and Chile, although some individuals, particularly juveniles, may winter further north (Harrington et al., 2001). A large percentage of the population winters in Bahia Lomas, Chile, thought to be the highest density of wintering red knot (Morrison and Ross, 1989). Northward migration begins as early as February, with individuals reaching the southeastern U.S. coast around March, and peak abundance occurs in April and early May (Harrington, 2001). Red knot arrive on Delaware and New Jersey coasts around the third week of April and remain through the first week of June, with peak abundance occurring in mid to late May, and few individuals remaining after June 5th (Robinson et al., 2003). The species is less prevalent in Massachusetts and eastern Canada during northward migration than during the late summer and early fall (Morrison et al., 1994).

The timing of arrival at Canadian breeding grounds has been poorly studied. Other red knot subspecies arrive in breeding territories in late May and early June, and typically begin establishing nesting territories within a few days (Parmelee and MacDonald, 1960). Eggs are laid in mid to late June and nesting is completed by mid July (Nettleship, 1974 *as cited in* Harrington, 2001). Red knots are known to have only one clutch per breeding season which typically consists of 4 eggs (Nettleship, 1974 *as cited in* Harrington, 2001). During fall migration individuals move south by mid-July, in Massachusetts numbers increase steadily until early August, then decrease between August 10 and August 20. First year juvenile birds may arrive latter and depart at the end of August, but tend not to concentrate at traditional staging areas like mature birds. The species is uncommon on the Southeastern U.S. coast before August during southward movement (Morrison and Harrington, 1979).

During spring and fall migration red knot stop on sandy shorelines, typically the intertidal zone near coastal inlets of bays and estuaries (Clark et al., 1993). Optimal foraging areas support a high density of infaunal prey organisms and/or horseshoe crab eggs, and are often associated with areas of high wave and current action, coincident with sandy substratum. Clark et al. (1993) demonstrated an association between areas of red knot foraging activity and close proximity to salt marshes, as well as a correlation between foraging activity and concentrations of other shorebirds. Red knot may be found on rocky or pebble beaches and in salt marshes and muddy areas where it exhibits foraging behavior similar to dowitchers (*Limnodromus* spp.) (Harrington, 2001). Nesting occurs most often on dry and elevated tundra, typically inland, and foraging occurs more frequently in non-marine areas during nesting (Harrington, 2001; Portenko, 1981).

Red knots wade in water to from 0.8 to 1.1 inches (2-3 cm) deep and may forage on eroded peat banks, during stops along the New England coast. It hunts primarily for infaunal bivalves, small mollusks, marine invertebrates, and gastropods. The amount of habitat used to forage for invertebrates depends on prey diversity and prey availability, and may be influenced by disturbance factors and interspecific competition (Harrington, 2001; Piersma and Koolhaas, 1997). In Massachusetts mussel spat are the most common prey species taken in July and August, where red knot forage about 2 hours on either side of low tide (Schneider and Harrington, 1981). In addition to animal prey, red knot may eat vegetation, under some circumstances, such as early arrival at high arctic breeding grounds before adequate insect prey bases have developed.

***Population Dynamics***

Red knot use the eastern U.S. coastal flyway as their primary migration route (Engelmoer and Roselaar, 1998). Important stopover areas are in Delaware, New Jersey, Maryland, Virginia and New England (USFWS, 2006). Of particular importance is the Delaware Bay staging area, with abundant seasonal food resources and foraging habitat. Individuals often increase in body mass by between 50 and 80 percent during the few weeks spent foraging on horseshoe crab (*Limulus polyphemus*) eggs there (Tsipoura and Burger, 1999, Botton et al., 1994). The red knot population using the Massachusetts coastline is mostly migratory and are most abundant during the early fall at staging areas near Plymouth-Duxbury Bay, Nauset Marsh, Monomoy National Wildlife Refuge, Scituate, and Plum Island/Parker River (USFWS, 2006). During the 1970's, 60 to 90 percent of the entire suspected population was observed in Massachusetts and New Jersey, during southward migration (USFWS, 2006). The maximum count of red knot recorded is approximately 950 at Plymouth-Duxbury Bay Complex, 300 at Nauset Marsh, 3,000 at Monomoy NWR, 2,800 at Scituate, and 100 at Plum Island/Parker River (Chan, 2003).

Studies of staging areas along the western Atlantic coast and of wintering areas in South America demonstrate a clear demographic decline. Morrison et al. (1994) calculated a fifteen percent rate of annual decline in adult red knot at stopover sites in maritime Canada, between 1974 and 1991 with an overall 10-year decrease of 81 percent. Donaldson et al. (2000) documented a population decline of more than 13 percent from 1974 to 1998. Surveys conducted in 1986 and repeated in 2002 showed a 55 percent decline in red knot wintering in six South American study areas (Niles et al., 2006). In Delaware Bay a consistent decline in maximum number of migrants was observed each year from 1999 through 2004.

***Status and Distribution***

Recent population estimates vary widely from approximately 30,000 to 140,000 individuals (USFWS, 2006; Harrington, 2001). Research by Baker et al. (2004) determined that the red knot population would likely decline to very low numbers by 2010. Subsequent counts of wintering red knot in 2004 and 2005 demonstrated evidence of the demographic trends predicted by Baker. The population was estimated at 152,900 ± 50,300 during the spring of 1989 (Morrison et al., 1994) and Clark et al. (1993) estimated the population at 94,460 during peak abundances at Delaware Bay. Peak counts at Delaware Bay in 2004 and 2005 diminished to 13,315 and 15,345, respectively (USFWS, 2006). Although the observed fluctuations of red knot at stopovers in the mid-Atlantic and New England are appropriate estimates of trends in demographics and total abundances at those areas, they may not necessarily be appropriate estimates of the entire population (Morrison et al., 1994; Clark et al., 1993; Robinson et al., 2003). Nonetheless, Clark et al. (1993) and others have demonstrated a clear downward trend in population size, as evident in counts from both stopovers areas and wintering sites in South America.

One red knot was observed during one boat survey and no other individuals were observed during aerial surveys conducted by the applicant or by MAS.

Changes in the management of horseshoe crab stocks since 1997, coupled with better conditions on breeding grounds in recent years, give some positive indications of population stabilization (USFWS, 2006). Recent surveys of migrants at Delaware Bay and Virginia, in conjunction with censuses of wintering birds in South America, indicate that the population decline may have abated. A slight increase of approximately 2,000 individuals (from ca. 13,300 to 15,300) in peak migrant abundance was recorded between 2004 and 2005 at Delaware Bay (USFWS, 2006).

***Threats***

The primary factor for the status of the red knot is the decline in food resources at the Delaware Bay spring staging area (USFWS, 2006; Baker et al., 2004; Robinson et al., 2003; Tsipoura and Burger, 1999; Botton et al., 1994; Clark et al., 1993; Piersma, 1987; Morrison and Harrington, 1979). The commercial harvest of horseshoe crabs used for bait in other fisheries and for biomedical research has reduced the spawning population in the Delaware Bay area, and subsequently led to a substantial decline in eggs available for migrating red knot. Because the red knot and other shorebird species rely on the seasonally abundant food resources at a small number of staging areas along their migration route, the decimation of any one food resource may have implications for overall population health (Wilson and Barter, 1998). The reduction in available food resources in Delaware Bay has caused individuals to be "underweight" and less likely to reach breeding grounds in good health. Baker et al. (2004) found survival rates declined by more than 35 percent in adults and by more than 45 percent in juveniles between spring 2000 and spring 2001. This decline has been attributed to reductions in key food resources at the stopover site preventing individuals from reaching threshold weights for migration to the arctic. A number of management actions have been under taken since the 1990's, by federal and state management agencies (i.e., ASMFC Horseshoe Crab Management Board) to limit the number of horseshoe crabs harvested.

Shoreline alteration and changes in long shore sediment drift patterns may also be a threat to red knot using the Massachusetts coastline (Niles et al., 2006). Of particular concern for conservation efforts is the species' high fidelity to stopover sites. Of the 3,316 red knot banded by Harrington et al. (1988) in nine years of study at Scituate, Massachusetts, 1,661 ± 724 banded birds used the stopover site during peak periods of migration. Similar patterns have been observed in Delaware Bay (Baker et al., 2004). Loss and/or degradation of coastal habitat in South America attributed to changes in drainage patterns by farm irrigation practices coupled with widespread oil pollution may be effecting the red knot wintering population as well (USFWS, 2006).

During migration periods, direct human disturbance is also a threat, particularly along beaches where their behavior may alter the foraging behavior of migrants, or where boats are present near roosting sites (USFWS, 2006). Peters and Otis (2007) found that red knot avoided roost sites that had boat activity within 1000 m. Anthropogenic disturbance in suitable foraging habitat throughout the Atlantic seaboard, including Massachusetts, is reported to have "major negative impact(s)" on red knot (Niles et al., 2006). Disturbance in conjunction with losses of intertidal foraging habitat may cause red knot to forage in sub-optimal areas.

**New England Cottontail (*Sylvilagus transitionalis*)**

The New England cottontail (*Sylvilagus transitionalis*) is a species of rabbit that is a candidate for protection under the ESA (Capitol Reports, 2006). Decline of New England cottontail populations are believed to be due to reduction of favorable habitats and displacement by the adaptable populations of the introduced Eastern cottontail (*Sylvilagus floridanus*) (MDFWELE, 2008; NatureServe, 2007). Historically, New England cottontails were present in all 14 counties of Massachusetts and prior to 1930 were the only cottontails appearing among 59 reports except for seven that were from Nantucket where Eastern cottontails were introduced in the late 1800's (MDFWELE, 2008).

***Description and Life History***

The New England Cottontail, first described as a species in 1895 from a Connecticut specimen, was the dominant cottontail species that was found throughout the northeast (MDFWELE, 2008). This species is now split into two species with the Appalachian cottontail (*Sylvilagus obscurus*) being found in the Appalachian Mountains from New York to Georgia and Alabama, and the New England cottontail being found from the Hudson River Valley in New York through central and southern New England (MDFWELE, 2008). New England cottontail numbers appear to have decreased sharply as has their distribution over the past 25 to 50 years (MDFWELE, 2008).

New England cottontails and Eastern cottontails cannot be easily identified by field observation. Differences can be determined with certainty by examining skull characteristics and measurements and by DNA techniques (MDFWELE, 2008).

The New England cottontail is an early successional or thicket-dwelling species (MDFW, 2008). This species appears to prefer areas that are brushy, areas with woodlands, areas with shrub-dominated wetlands and areas that are mountainous (MDFWELE, 2008). This species can be found where clearcuts are regenerating, in dense coniferous areas, and along powerline corridors or highway medians that have dense coniferous habitats (MDFWELE, 2008). When large trees are growing in a stand, shrub layers tend to thin and a habitat is created that is no longer suitable for New England cottontails (USFWS, 2008a).

Home ranges of this species have been noted to be between 0.5 to 8.3 acres (2023 $m^2$ to 33,588 $m^2$) depending on the habitat and the geographical area with males having a larger home range than the females (MDFWELE, 2008). New England cottontails are active at dawn and dusk or at night, and feed on tender grasses and herbs in spring/summer, and bark, twigs and buds of young trees and shrubs in winter (MDFWELE, 2008; USFWS, 2008a). This species forages alone, and they groom themselves but not each other (SNMNH, 2008). This species' breeding period is from March to July, occasionally extending to September (MDFWELE, 2008). The average litter size is five (range three-eight) and there are two or three litters per year (MDFWELE, 2008).

***Distribution and Abundance***

As noted previously, New England cottontails were present in all 14 counties of Massachusetts and prior to 1930 were the only cottontails appearing among 59 reports except for seven that were from Nantucket where Eastern cottontails were introduced in the late 1800's (MDFWELE, 2008). Of four surveys conducted during 1950-1993, New England cottontails maintained an overall abundance of approximately 22 percent of all cottontail specimens (MDFW, 2008). In a 1990-1993 survey, New England cottontails were found in only six counties in Massachusetts, while the Eastern cottontail was found in 13 of 14 counties (MDFW, 2008). Small populations of New England cottontails were observed in Barnstable County and southern Berkshire County during a 2000-2003 survey conducted by other researchers (MDFW, 2008).

***Threats***

Reduced extent of thicket habitat is believed to be the primary reason for decline in the range and numbers of New England cottontails (USFWS, 2008a). Commercial and residential development in pitch pine-scrub oak barrens or other early successional communities has contributed to fragmentation, degradation, or eradication of habitat for this species (MDFW, 2008). In addition, the introduction of exotic invasive species such as multiflora rose (*Rosa multiflora*), honeysuckle bush (*Lonicera japonica*), and autumn olive (*Elaeagnus umbellata*) has changed types of habitat available to New England cottontails (USFWS, 2008a). Stands dominated by such non-native species may not provide New England cottontails with food resources that native plants would provide (USFWS, 2008a). White-tailed deer (*Odocoileus virginianus*) are also found in extremely high densities throughout the New England cottontail range and not only eat many of the same plants as New England cottontails, but also can affect the structure and density of many understory plants that provide a thicket habitat (USFWS, 2008a).

## 4.3 SOCIOECONOMIC RESOURCES AND LAND USE

This section assesses the existing socioeconomic resources and land use in the area to provide an understanding of the people who live in the area and the economic conditions that exist including information about housing, construction and manufacturing industries, service industries, waste disposal, energy industries and population statistics such as race and population density. This information provides a baseline from which to compare socio economic impacts as discussed in Section 5.

### 4.3.1 Socioeconomic Analysis Area

This section addresses the geographic scope of the study area and the sources of information used in the study.

#### *4.3.1.1 Metropolitan Statistical Area*

With respect to socioeconomic analysis, the MMS defined the region of impact (ROI) as four locations in Massachusetts; Barnstable County, Nantucket Island in Nantucket County, Martha's Vineyard in Dukes County, and New Bedford in Bristol County in Massachusetts, and Quonset, in Washington County, Rhode Island.

Barnstable County was included in the ROI because this would be the daily debarkation point for workers involved in construction and operation and would require the presence of an on-shore support base to support offshore construction and annual O&M activities, and the presence of on-shore infrastructure such as the 115 kV transmission cable system that would convey power from the project to the existing regional T&D system. Nantucket and Martha's Vineyard would be included in the ROI due to their close proximity to the proposed action and possible contribution of workers. Quonset Rhode Island and Washington County Rhode Island were included in the ROI as this is where fabrication and assembly of the WTB components is likely to occur as well as the majority of construction and decommissioning activities would be staged here. Bristol County was included because maintenance vessels related to the proposed action would be operated out of New Bedford, in Bristol County. The manufacture and purchase of much of the specialized equipment that would comprise the WTGs such as the rotors, generators, and nacelles, etc. would occur outside the ROI.

Additionally, construction and operational employees may come from areas beyond the ROI, and that in a broader sense, the entire New England region would be affected by the proposed action via the electricity delivered into the New England electricity grid. However, the majority of the socio-economic impacts would be in the referenced ROI.

Socioeconomic data provided to describe existing socioeconomic conditions in this section came from the U.S. Census unless otherwise noted (http://factfinder.census.gov). The most recent available U.S. Census community data for Barnstable County, Massachusetts and Washington County, Rhode Island came from 2005 estimates, and the most recent available community data for Nantucket County, Dukes County, and Bristol County, Massachusetts came from the 2000 census (U.S. Census, 2005 and U.S. Census, 2000).

### 4.3.2 Urban and Suburban Infrastructure

#### *4.3.2.1 Housing*

In 2005, there were approximately 100,000 housing units in Barnstable County, with approximately 80 percent of them owner occupied, and 20 percent renter occupied. The vacancy rate for owner occupied homes was approximately 1 percent and the vacancy rate for rental homes was 10 percent.

Approximately 89 percent of those vacant units are considered to be seasonal or recreational in nature, which would leave approximately 1,200 units available for rent.

In 2000, there were approximately 9,210 housing units in Nantucket County, with approximately 85 percent of them owner occupied, and 15 percent renter occupied. The vacancy rate was approximately 2.4 percent for owner occupied homes and the vacancy rate was approximately 3.9 percent for rental homes. Approximately 56.1 percent of those vacant units are considered to be seasonal, recreational, or occasional use.

In 2000, there were approximately 14,836 housing units in Dukes County, with approximately 71.3 percent of them owner occupied, and 28.7 percent renter occupied. The vacancy rate for owner occupied homes was approximately 1.3 percent and the vacancy rate for rental homes was approximately 3.6 percent. Approximately 53.9 percent of those homes are considered to be seasonal, recreational, or occasional use homes.

During the summer months vacancy rates in Barnstable County, Nantucket County and Dukes County decline as these areas are very popular summer vacation destinations for tourists and available vacant rental units help to address this seasonal demand.

In 2005, there were approximately 59,903 housing units in Washington County, with approximately 72.7 percent of them owner occupied, and 27.3 percent renter occupied. The vacancy rate for owner occupied homes was approximately 0.9 percent and the vacancy rate for rental homes was approximately 4.8 percent. Approximately 14.4 percent of those homes are considered to be seasonal, recreational, or occasional use homes.

In 2000, there were approximately 216,918 housing units in Bristol County, with approximately 61.6 percent of them owner occupied, and 38.4 percent renter occupied. The vacancy rate for owner occupied homes was approximately 0.8 percent and the vacancy rate for rental homes was approximately 5.5 percent. Approximately 0.9 percent of those homes are considered to be seasonal, recreational, or occasional use homes.

Median house values in all counties located in the ROI are considerably higher than the average applicable state median housing values indicating there is a high level of desirability and demand for housing stock in these locations. Further details on house prices are provided in Section 4.3.3.2 of this document.

#### *4.3.2.2 Construction and Manufacturing Industries*

In 2002, construction and manufacturing sectors employed 7.1 percent and 4.1 percent of the population of Barnstable County, respectively. From 1990 through 2002, the construction and manufacturing industries in Barnstable County have had an employment growth rate of 5.8 percent and -0.07 percent, respectively. In 2000, construction and manufacturing sectors employed 12.4 percent and 1.8 percent of the population of Nantucket County, respectively. From 1990 through 2000, the construction and manufacturing industries in Nantucket County have had an employment growth rate of -0.4 percent and 0.5 percent, respectively. In 2000, construction and manufacturing sectors employed 18.3 percent and 2.9 percent of the population of Dukes County, respectively. From 1990 through 2000, the construction and manufacturing industries in Dukes County have had an employment growth rate of 10 percent and 1.3 percent, respectively. In 2005, construction and manufacturing sectors employed 4.1 percent and 6 percent of the population of Washington County, respectively. From 1990 through 2005, the construction and manufacturing industries in Washington County have had an employment growth rate of 0.8 percent and -3.0 percent, respectively. In 2000, construction and manufacturing sectors employed 6.9 percent and 18.5 percent of the population of Bristol County, respectively.

#### 4.3.2.3 Service Industries

The main service industries in the ROI include: Educational Services, Professional, Scientific and Technical Services, Admin, Support, Waste Management, Remediation Services, and Accommodation and food services. Additional information on business activity by job sector is provided in Section 4.3.3.2.2.

#### 4.3.2.4 Waste Disposal and Transit Facilities

There are no waste disposal facilities in Barnstable County. Solid waste is collected at local and regional transfer stations and sent to the SEAMASS incinerator in Rochester, Massachusetts via rail or truck. Commercial solid waste is either taken directly to SEAMASS by a private hauler, or a fee is paid to the truck transfer station/railhead transfer station. Waste disposal in Rhode Island is handled by the Central Landfill, which spans across 1,200 acres and is located on Shun Pike in Johnston, Rhode Island. The Rhode Island Resource Recovery Corporation has owned and operated the Central Landfill since December 1980, and currently manages approximately 4,000 tons (3,628,739 kg) of residential and commercial waste per day.

#### 4.3.2.5 Military Activity

The MMR is located on Cape Cod and consists of 21,000 acres (85 $km^2$) of land split between the towns of Bourne, Mashpee, and Sandwich. Units operating at MMR include:

- Massachusetts Air National Guard (ANG), Otis ANG Base;
- Massachusetts Army National Guard (ARNG), Camp Edwards;
- U.S. Air Force's 6th Space Warning Squadron PAVE PAWS radar site (Cape Cod Air Force Station);
- USCG Air Station Cape Cod;
- Veterans Administration Cemetery; and
- U.S. Department of Agriculture (USDA).

#### 4.3.2.6 Energy Industries

##### 4.3.2.6.1 Electrical Generating Capacity

Canal Station, owned by Mirant Corporation, is the bulk electric generation facility that currently serves Barnstable County. The facility is located in Bourne, Massachusetts, and has a 1,120 MW generation capacity (560 MW peak unit) and is capable of being run on both number six fuel oil and natural gas. The electricity supply produced by the proposed action would be consumed primarily on the Cape and Islands. Since electricity follows the path of least resistance, the power would flow to the homes, schools and businesses of the Cape and Islands. Only when the proposed action is producing more power than demanded locally would some of the power cross the Cape Cod Canal via high voltage transmission lines. The expected production of 182 MWs of electricity in average wind conditions would meet three quarters of the 230 MW average electric demand of Cape Cod and the Islands.

##### 4.3.2.6.2 Base and Surge Load Servicing

The electricity grid is built with redundancy to account for planned and unplanned outages from power production facilities. The New England Region electrical grid system is run by ISO-NE, an independent system operator, which ensures that adequate base load and peak demand capacity is available at all times. As part of the redundancy of the electrical grid system, ISO-NE requires a certain capacity of spinning reserves, which are sources of power available to start up quickly to compensate for any sudden drop in electricity production. During a power plant outage, whether a conventional plant or a wind plant, backup is provided by the entire interconnected utility system. The system operating strategy strives to make best use of all elements of the overall system, taking into account the operating characteristics of each generating unit and planning for contingencies such as plant or transmission line outages. The utility system is also designed to accommodate load fluctuations, which occur continuously. This feature facilitates accommodation of wind plant output fluctuations.

##### 4.3.2.6.3 Transmission and Relay System

The existing transmission system on Cape Cod operates at 115 kV and 345 kV. Crossing the Cape Cod Canal, there are two 115 kV lines and two 345 kV lines. The 115 kV lines are capable of carrying 225 MW each and the 345 kV lines are capable of carrying 1000 MW each. The existing substation in the town of Barnstable, Massachusetts operates at 115 kV and, once it has been upgraded, would be able to accept and deliver the additional power from the two 115 kV lines from the proposed action.

##### 4.3.2.6.4 Wholesale Energy Market

ISO-NE also is responsible for regulating the electricity market in New England. Electricity prices are determined through the ISO-NE's wholesale energy market. The wholesale energy market functions just like an auction. Electric utility companies and competitive suppliers forecast customers' electricity consumption, and bid to buy wholesale power at a specified price per megawatt-hour (MWh). Similarly, power plants offer into the auction to produce a certain amount of electricity at a specified price per MWh. The ISO-NE takes the lowest priced energy bid by suppliers until the point where total demand equals supply.

### 4.3.3 Population and Economic Background

#### *4.3.3.1 Demographics*

The following information is largely presented based on the county statistics for those counties likely to supply the goods and services needed for construction, operation, and decommissioning of the project. There are four counties in Massachusetts and one in Rhode Island.

##### 4.3.3.1.1 Population

In 2005, Barnstable County had a household population of 221,000, with 116,000 (52 percent) females and 105,000 (48 percent) males. The average annual population growth rate from 1990 through 2005 was 1.2 percent.

In 2000, Nantucket County had a total population of 9,520, with 4,884 (51.3 percent) males and 4,636 (48.7 percent) females. The average annual population growth rate from 1990 through 2000 was 5.8 percent.

In 2000, Dukes County had a total population of 14,987 with 7,323 (48.9 percent) males and 7,664 (51.1 percent) females. The average annual population growth rate from 1990 through 2000 was 2.9 percent.

In 2005, Washington County had a total population of 123,322 with 60,221 (48.8 percent) males and 63,101 (51.2 percent) females. The average annual population growth rate from 1990 through 2005 was 0.7 percent.

In 2000, Bristol County had a total population of 534,678 with 256,747 (48.0 percent) males and 277,931 (52.0 percent) females. The average annual population growth rate from 1990 through 2000 was 0.56 percent. Further information on population of the ROI is provided in Table 4.3.3-1.

#### 4.3.3.1.2 Age

The median age in Barnstable County in 2005 was 45.6 years. Nineteen percent of the population were under 18 years, 6 percent were between 18 and 24 years, 24 percent were between 25 and 44 years, 28 percent were between 45 and 64 years, and 23 percent were 65 years and older.

The median age in Nantucket County in 2000 was 36.7 years. Approximately 20.7 percent of the population were 19 years and younger, 5.9 percent were between 20 and 24 years, 40.5 percent were between 25 and 44 years, 22.5 percent were between 45 and 64 years, and 10.5 percent were 65 years and older.

The median age in Dukes County in 2000 was 40.7 years. Approximately 24.5 percent of the population were 19 years and younger, 3.7 percent were between 20 and 24 years, 29.6 percent were between 25 and 44 years, 27.8 percent were between 45 and 64 years, and 14.4 percent were 65 years and older.

The median age in Washington County in 2005 was 40.5 years. Approximately 27.5 percent of the population were 19 years and younger, seven percent were between 20 and 24 years, 28.4 percent were between 25 and 44 years, 24.3 percent were between 45 and 64 years, and 12.7 percent were 65 years and older.

The median age in Bristol County in 2000 was 36.7 years. Approximately 27.3 percent of the population were 19 years and younger, 5.9 percent were between 20 and 24 years, 30.5 percent were between 25 and 44 years, 22.2 percent were between 45 and 64 years, and 14.2 percent were 65 years and older. Further information on age is provided in Table 4.3.3-1.

#### 4.3.3.1.3 Race and Ethnic Composition

In Barnstable County in 2005, of people who were one race, 96 percent of the population was White; two percent were Black or African American; less than 0.5 percent were American Indian and Alaska Native; one percent were Asian; less than 0.5 percent were Native Hawaiian and Other Pacific Islander, and one percent were some other race. In addition, one percent reported two or more races and two percent of the people in Barnstable County were Hispanic or Latino. Ninety-four percent of the people in Barnstable County were White non-Hispanic. (People of Hispanic origin may be of any race [U.S. Census, 2005]).

In Nantucket County in 2000, of people who were one race, 87.8 percent were White; 8.3 percent were Black or African American; 0.6 percent were Asian; and 1.6 percent were some other race. In addition, 1.6 percent reported two or more races and 2.2 percent of the people in Nantucket County were Hispanic or Latino.

In Dukes County in 2000, of people who were one race, 90.7 percent were White; 2.4 percent were Black or African American; 1.7 percent were American Indian and Alaska Native; 0.5 percent were Asian; 0.1 percent were Native Hawaiian and Other Pacific Islander; and 1.5 percent were some other race. In addition, 3.2 percent reported two or more races and one percent of people in Dukes County were Hispanic or Latino.

In Washington County in 2005, of people who were one race, 94.8 percent were White; 0.9 percent were Black or African American; 0.9 percent were American Indian and Alaska Native; 1.5 percent were Asian; and 0.5 percent were some other race. In addition, 1.4 percent reported two or more races and 1.4 percent of people in Washington County were Hispanic or Latino.

In Bristol County in 2000, of people who were one race, 91.0 percent were White; 2.0 percent were Black or African American; 0.2 percent were American Indian and Alaska Native; 1.3 percent were Asian; 0.0 percent were Native Hawaiian and Other Pacific Islander; and 3.1 percent were some other race. In addition, 2.3 percent reported two or more races and 3.6 percent of people in Bristol County were Hispanic or Latino. Further information on ethnicity is provided in Table 4.3.3-1. For information regarding Native American tribes, refer to section 4.3.5.3.

#### 4.3.3.1.4 Education

In Barnstable County in 2005, 94 percent of the adult population had graduated high school and 36 percent had a bachelor's degree or higher (U.S. Census, 2005). In Dukes County in 2000, 90.4 percent of the adult population had graduated high school and 38.4 percent had a bachelor's degree or higher (U.S. Census, 2000). In Nantucket County in 2000, 91.6 percent of the adult population had graduated high school and 38.4 percent had a bachelor's degree or higher (U.S. Census, 2000). In Washington County in 2005, 90.6 percent of the adult population had graduated high school and 40.6 percent had a bachelor's degree or higher (U.S. Census, 2005). In Bristol County in 2000, 73.2 percent of the adult population had graduated high school and 19.9 percent had a bachelor's degree or higher (U.S. Census, 2000).

### *4.3.3.2 Economic Factors*

#### 4.3.3.2.1 Current Economic Baseline Data

In 2005, the median income of households in Barnstable County was $54,439. Seventy-two percent of the households received earnings and 25 percent received retirement income other than Social Security. Forty-one percent of the households received Social Security. The average income from Social Security was $14,696. These income sources are not mutually exclusive; that is, some households received income from more than one source (U.S. Census, 2005).

In 2005, seven percent of people in Barnstable County were in poverty. Nine percent of related children under 18 were below the poverty level, compared with 5 percent of people 65 years old and over. Five percent of all families and 18 percent of families with a female householder and no husband present had incomes below the poverty level (U.S. Census, 2005).

In 2005, the median income of households in Washington County was $62,536. Eighty-one percent of the households received earnings and 24 percent received retirement income other than Social Security. Twenty-nine percent of the households received Social Security. The average income from Social Security was $15,466. These income sources are not mutually exclusive; that is, some households received income from more than one source (U.S. Census, 2005).

In 1999, the median income of households in Dukes County was $45,559. Eighty-three percent of the households received earnings and 15.1 percent received retirement income other than Social Security. Twenty-six percent of the households received Social Security. The average income from Social Security was $11,008. These income sources are not mutually exclusive; that is, some households received income from more than one source (U.S. Census, 2000).

In 1999, the median income of households in Nantucket County was $55,522. Eighty-seven percent of the households received earnings and 12.2 percent received retirement income other than Social

Security. Twenty percent of the households received Social Security. The average income from Social Security was $11,567. These income sources are not mutually exclusive; that is, some households received income from more than one source (U.S. Census, 2000).

In 1999, the median income of households in Bristol County was $43,496. Seventy-seven percent of the households received earnings and 16.9 percent received retirement income other than Social Security. Twenty-eight percent of the households received Social Security. The average income from Social Security was $10,237. These income sources are not mutually exclusive; that is, some households received income from more than one source (U.S. Census, 2000).

#### 4.3.3.2.2 Business Activity by Industrial Sector

Among the most common occupations in Barnstable County in 2005 were: management, professional, and related occupations, 32 percent; sales and office occupations, 27 percent; service occupations, 23 percent; construction, extraction, maintenance and repair occupations, 11 percent; and production, transportation, and material moving occupations, 6 percent. Seventy-three percent of the people employed were private wage and salary workers; 14 percent were Federal, state, or local government workers; and 13 percent were self-employed (U.S. Census, 2005).

Among the most common occupations in Dukes County in 2000 were: management, professional, and related occupations, 32 percent; sales and office occupations, 25 percent; construction, extraction, and maintenance occupations, 19 percent; service occupations, 16 percent; production, transportation, and material moving operations, 8 percent; and farming, fishing, and forestry occupations, 1 percent. Sixty-six percent of the people employed were private wage and salary workers; 22 percent were self-employed; and 12 percent were government workers (U.S. Census, 2000).

Among the most common occupations in Nantucket County in 2000 were: management, professional, and related occupations, 30 percent; sales and office occupations, 24 percent; construction, extraction, maintenance and repair occupations, 22 percent; service occupations, 17 percent; production, transportation, and material moving occupations, 6 percent; and farming, fishing, and forestry occupations, 1 percent. Sixty-two percent of the people employed were private wage and salary workers; 25 percent were self-employed; and 12 percent were Federal, state, or local government workers (U.S. Census, 2000).

Among the most common occupations in Washington County in 2005 were: management, professional, and related occupations, 40 percent; sales and office occupations, 22 percent; service occupations, 19 percent; construction, extraction, maintenance and repair occupations, 10 percent; production, transportation, and material moving occupations, 8 percent; and farming, fishing, and forestry occupations, 1 percent. Seventy-three percent of the people employed were private wage and salary workers; 19 percent were Federal, state, or local government workers; and 7 percent were self-employed (U.S. Census, 2005).

Among the most common occupations in Bristol County in 2000 were: management, professional, and related occupations, 31 percent; sales and office occupations, 26 percent; construction, extraction, maintenance and repair occupations, 10 percent; service occupations, 15 percent; production, transportation, and material moving occupations, 18 percent; and farming, fishing, and forestry occupations, less than 1 percent. Eighty-two percent of the people employed were private wage and salary workers; 5 percent were self-employed; and 13 percent were Federal, state, or local government workers (U.S. Census, 2000).

#### 4.3.3.2.3 Employment

In 2005, there was an estimated labor force of 113, 026 in Barnstable County with an unemployment rate of 7.4 percent. In 2000, there was an estimated labor force of 5,788 in Nantucket County with an unemployment rate of 3.1 percent[16]. In 2000, there was an estimated labor force of 8,150 in Dukes County with an unemployment rate of 1.8 percent. In 2005, there was an estimated labor force of 71,286 in Washington County with an unemployment rate of 3.1 percent. In 2000, there was an estimated labor force of 132,883 in Bristol County with an unemployment rate of 5.3 percent.

#### 4.3.3.2.4 Income and Wealth

In 2005, the median income of households in Barnstable County was $54,439 versus the state of Massachusetts median income of $57,184. In 2000, the median income of households in Nantucket County was $55,522 versus the state of Massachusetts median income of $46,753. In 2000, the median income of households in Dukes County was $45,559 versus the state of Massachusetts median income of $46,753. In 2005, the median income of households in Washington County was $62,536 versus the state of Rhode Island median income of $51,458. In 2000, the median income of households in Bristol County was $43,496 versus the state of Massachusetts median income of $46,753.

#### 4.3.3.2.5 Property Values

In 2005, the median house value in Barnstable County was $400,500 versus the state of Massachusetts median house value of $361,500. In 2000, the median house value in Nantucket County was $577,500 versus the state of Massachusetts median house value of $185,700. In 2000, the median house value in Dukes County was $304,000 versus the state of Massachusetts median house value of $185,700. In 2005, the median house value in Washington County was $349,900 versus the state of Rhode Island median house value of $281,300. In 2000, the median house value in Bristol County was $151,500 versus the state of Massachusetts median house value of $185,700. In summary, the information shows that the counties within the ROI have considerably higher housing values than the overall housing values of the state in which they are located (with the exception of Bristol County), indicating the high demand for housing in these areas and relative wealth in these areas.

### *4.3.3.3 Environmental Justice Considerations*

This section contains environmental justice statistics to determine whether the construction and operation of the proposed action would have a significant adverse effect on minority and low-income populations. As part of the environmental justice data, socioeconomic characteristics of the area of the proposed action have been examined to determine whether the proposed would disproportionately impact any minority or low-income population(s).

#### 4.3.3.3.1 Federal Guidance

The USEPA Headquarters Office of Environmental Justice defines environmental justice as the following:

> *"Environmental Justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people, including a racial, ethnic, or socioeconomic group, should bear a disproportionate share of the negative environmental consequences*

[16] At the time of preparation of this DEIS, 2005 data was not available from the US Census on Nantucket County and Dukes County.

*resulting from industrial, municipal, and commercial operations or the execution of federal, state, local, and tribal programs and policies."*

The concept of performing an environmental justice analysis for the proposed action is related to the establishment of Executive Order 12898, entitled "Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations" (February 11, 1994). The order requires Federal agencies to consider disproportionate adverse human health and environmental impacts on minority and low-income populations.

The focus of an environmental justice analysis is the determination of whether the construction and operation of a proposed action would have both adverse and disproportionate impacts on minority and low income populations. Minority populations are generally defined by USEPA as areas that have a "meaningfully greater" percent of minorities than the general population in the surrounding area, and low income populations are defined based on the U.S. Census poverty statistics. In performing the environmental justice analysis, the MMS used the methodology in USEPA's "Final Guidance for Incorporating Environmental Justice Concerns in USEPA's NEPA Compliance Analyses, April 1998."

The poverty rate of Barnstable County was 6.6 percent in 2005, versus the state poverty rate of 10.3 percent. The poverty rate in Washington County was 6.3 percent in 2005 versus the state wide poverty rate of 12.3 percent. The poverty rates in Nantucket, Dukes, and Bristol Counties were 7.5 percent, 7.3 percent, and 10.0 percent, respectively in 2000 versus the state wide poverty rate of 9.3 percent. This poverty rate information shows that overall area of the ROI is in general more affluent than the rest of the state, which indicates it is unlikely to be an environmental justice area of concern.

The percent minorities in Barnstable, Nantucket, Dukes, and Bristol Counties were 6.6 percent, 13.1 percent, 10.0 percent, and 10.6 percent, respectively in 2000, versus a state wide percentage of 18.1 percent (U.S. Census, 2000).[17] The percent minorities in Washington County was 5.1 percent in 2005 versus a state wide average of 17 percent. These statistics show again that the ROI in general is not an area of environmental justice concern as the ROI has a smaller percentage of minorities than the rest of the state. There are two tribes of Indians in the ROI, the WTGHA and the Wampanoag Indians of Mashpee. See Section 4.3.3.1.3 for a description of them, and see Section 5.0 for information on environmental impacts to these areas. The Environmental Justice Impact assessment is provided at Section 5.3.3.3.

Although the statistics for Barnstable County as a whole indicate that the area is not an environmental justice area of concern, the Massachusetts Environmental Justice GIS Map shows that there is a smaller census block group in and around Hyannis, Massachusetts that is an Environmental Justice Population (see Figure 4.3.3-1). The Mass GIS defines an Environmental Justice Population as any area that has: (1) greater than or equal to 25 percent minority population; or (2) less than or equal to a median household income of $30,515; or (3) less than 75 percent of the households are English proficient; or greater than 25 percent of a foreign born population. (http://www.mass.gov/mgis/cen2000_ej.htm). The proposed action on-land cable portion of the proposed action is located outside of this area, but the existing substation where the cable connects is located within this area. Impacts are described in Section 5.3.3.3 of this document.

[17] To obtain the total minority population, the "population of one race, white alone, was subtracted by the total population (to obtain all minorities), and divided by the total population (to obtain percent minorities). It should be noted that, using this methodology, any individual identified as "other race" or "two or more races" is considered a member of a minority.

### 4.3.4 Visual Resources

Visual resources were surveyed and assessed via two main groupings: Visual Resources associated with Historic Areas, to address requirements of Section 106 historic review requirements, and visual resources associated with Recreational Areas, to address visual impact under the National Environmental Policy Act regulations. For the purposes of this work, recreational areas include but are not limited to beaches, parks, conservation lands, and ocean areas.

The land area surrounding the site of the proposed action has a variety of historic structures and recreational areas that would be in view of the proposed action. With respect to historic areas, there are both individual homes on the NRHP and larger historic districts on the NRHP that would have a view of the proposed action, including the island of Nantucket which is designated a National Historic District. With respect to recreational areas, Cape Cod, Nantucket, Martha's Vineyard and the waters of Nantucket Sound are well known for coastal recreational and summer tourism activities including beach going, swimming, boating, fishing, hiking, biking, picnicking, golfing, and bird watching. Marinas, yachts clubs, and public boat ramps line most of the harbors and inlets that have sufficient water depths.

#### *4.3.4.1 Visual Resources Associated with Historic Structures and Districts*

In order to assess visual impacts to historic structures, 12 simulation locations were selected in consultation with the MEPA and MHC as representative worst case visual impacts to historic structures from the proposed action (Report No. 4.3.4-1). Table 4.3.4-1 indicates the historic properties and districts in the area that were assessed and their distance to the proposed action and Figure 4.3.4-1 shows the location of these areas on a map. Figure 4.3.4-2 shows the existing view (prior to the proposed action) toward the site from the nearest unobstructed viewing area from each of the visual simulation locations plus a photograph of the historic structure that would be affected, and additional photographs that show the general visual character and context at each location.

A description of the visual character and setting at each of the 12 visual simulation locations is presented below, based upon field reconnaissance, background research, and review of NRHP Inventory Nomination Forms, where available, and other documentation in MHC files.

**South Side of Cape Cod**

***Nobska Point Light Station, Woods Hole, Falmouth (VP 1 in Figure 4.3.4-1; Character photos on Figure 4.3.4-2, sheets 1-7)***

The Nobska Point Light Station complex dates from 1876, when the existing white cylindrical tower was constructed to replace a navigational light atop a keeper's dwelling that had operated since 1828. The light is a major navigational aid located on a rocky headland near the entrance to Woods Hole Harbor. A photograph of the structure and the existing view toward the site of the proposed action is shown on sheet 1; locations of these photographs are shown on sheet 2. The complex consists of the 40 ft-high light tower with entry porch (1876), two keeper's dwellings (1876, 1990) connected by a porch, a brick oil house (1876), paint lockers (1876), garage (1931) and a radio beacon building (1937). The light has been unmanned and automated since 1985.

The Light Station complex is listed on the NRHP as part of the Lighthouses of Massachusetts Thematic Group. The 2.11 acre (8,538 $m^2$) site is largely bare of vegetation and the white tower can be seen clearly from all directions. According to MHC's Lighthouse Information Form (MHC, 1981) "the Light possesses integrity of location, design, setting, materials and workmanship as well as significant associations with the development of aids of navigation in Massachusetts. It is important for its scenic qualities, sited on a bluff overlooking Vineyard Sound, and for its strategic location. The complex meets criteria A and C of the NRHP on the state level."

Visitors to the historic lighthouse are presented with open views of Nantucket Sound (see sheet 1) from the southeast to the southwest, including views of Martha's Vineyard. The base of the light is publicly accessible, and a plaque provides historic information to visitors that park at a small adjacent lot.

Character photos of the area around the Nobska Light are shown in Viewpoint (VP) 1 photographs on sheets 4-6. Locations are shown on sheet 2. The area is generally characterized by low to medium-density residential land use, with commercial use in the village of Woods Hole to the northwest. Large homes are generally scattered along winding roads among low wooded hills. Views toward the water from most roads and residences are generally well screened by trees. Open views easterly toward the site of the proposed action are available from Fay Road, and are expected from the easterly and southeasterly-facing upper stories of area homes. Open views of the site of the proposed action were not found in Woods Hole village.

***Other nearby viewpoints not selected for simulation***

A representative historic structure and the view toward the proposed action from the southern end of VP 2, the locally-designated Woods Hole Historic District, are shown on sheet 6. The location of VP 2 is shown on sheet 2, and was the only ground-level location found within this district with some view of Nantucket Sound toward the site of the proposed action. The view is partially blocked by the point of land at Nobska Light and by Martha's Vineyard.

VP 3 at the Woods Hole School on 24 School Street is shown on sheet 6. Photograph VP 3-CE-4 on sheet 7 shows no view of Nantucket Sound at this interior historic property.

A representative photograph of VP 4 in the locally designated East Falmouth Historic District is shown on sheet 7; the location is shown on sheet 3. No ground-level views of Nantucket Sound toward the proposed action were found in this historic district.

***Cotuit (see Figure 4.3.4-1 for VP 5; Character photos in Figure 4.3.4-2, sheets 8-11), Town of Barnstable***

The Village of Cotuit Historic District is included in the Town of Barnstable Multiple Resource Area (MRA), which was listed on the NRHP on November 10, 1987. Other Barnstable MRAs in the vicinity of the proposed action viewshed and described in this section include historic districts in Wianno, Craigville, Centerville, and Hyannis Port.

The Cotuit Historic District, westernmost of the villages in Barnstable, occupies a neck of land surrounded by Popponesset Bay to the west, Nantucket Sound to the south, and Osterville Harbor to the east. Most of the 107 buildings in the district are residential, although some commercial and institutional buildings have also been designated in the village colonial center. A representative historic structure is shown on sheet 8.

Character photos of the district are presented on sheets 10-11; locations are shown on sheet 9. Public access and views to the shoreline and south-southeasterly toward the site of the proposed action are limited. Street level views toward the water are generally broken/partially screened by vegetation and structures. However, views are likely available from many of the large shoreline homes, especially from the upper stories.

The National Register Criteria Statement found the Cotuit Historic District significant as a major collection of 19th and early 20th century buildings related to the maritime industries and summer resort activities. The district was determined to possess integrity of location, design, setting, materials, workmanship, feeling and association, and to meet criteria A, B, and C of the NRHP (MHC, Village Summary Sheet: Cotuit, 1987).

Cotuit was first settled in the early 1700s in the interior Santuit area, near what is now Route 28, to utilize fertile lands and early transportation corridors. As local economies shifted from land-based activities to the maritime industries in the early 19th century, the settlement shifted to the shore along the west side of Cotuit Bay. Key maritime activities included oystering, fishing, shipbuilding, coastal trade, and salt making. Many of the houses in the district were built by ship captains, and reflected their wealth. As the maritime trades ebbed in the late 19th century, summer residents discovered the village. Federal and Greek Revival architectural styles represent the district's early seafaring heritage, while later Italianate, Second Empire, Gothic Revival, Queen Anne and Colonial Revival structures reflect the area's later evolution into a quiet summer resort.

Most buildings are framed by mature wooded vegetation. Cotuit has retained a quiet, settled atmosphere due to its location several miles from busy main routes. Its small harbor offers moorings for many boats, and the village has an active local sailing program. The village is traditionally known for its oysters, which continue to be harvested in Cotuit Bay. Oyster Harbors, a gated community of large seasonal homes, is located across Cotuit Bay to the east and is not included in the Barnstable MRAs.

***Wianno (see Figure 4.3.4-1 for location of VP 6; Character photos in Figure 4.3.4-2, sheets 12-16)***

The Wianno Historic District in the Village of Osterville is comprised of 28 main buildings and 13 outbuildings on approximately 40 acres (0.16 $km^2$) along Sea View Avenue and Wianno Avenue. The lands were originally assembled in the late 19th century by a consortium of businessmen and developed as a summer colony. The large well-kept lots on either side of Sea View Avenue along Nantucket Sound contain grand Shingle Style and Colonial Revival style summer houses, most of which were constructed between the late 19th century and World War I.

The focal point of the Wianno Historic District is the Wianno Club on Sea View Avenue, a massive three-story shingled main building and two-story rear ell, both with mansard roofs. The Wianno Club is shown on sheet 14, photograph VP 6-CE-10. The structure was designed by architect Horace Frazer of Boston (who also designed a number of private residences in the district). The Club overlooks Nantucket Sound on almost 1,000 ft (305 m) of beach frontage. The building is described as architecturally extremely significant, as much of its original and interior detailing survives. The structure was individually listed in the NRHP in 1979, and was listed as a Barnstable MRA in 1987.

On the Sound side of Sea View Avenue, which runs parallel to the shore, the structures are regularly spaced with open well-maintained lawns and unobscured views toward the site of the proposed action to the south. Across Sea View Avenue, views toward the site of the proposed action are limited to areas between intervening structures. Mature trees and large hedges also effectively screen views.

The National Register Criteria Statement found the Wianno Historic District in excellent condition, and possessing integrity of location, design, setting, materials, workmanship, feeling and association. It is significant as one of three well-preserved summer resort colonies developed in Barnstable in the late 19th century, and contains an extraordinary collection of Colonial Revival and Shingle Style architecture. The district is also significant for its association with a notable Boston architect and many prominent seasonal residents. The district meets criteria A, B, and C of the NRHC (MHC, Wianno Historic District Form B, 1986).

***Other nearby areas visited but not selected for simulation***

No views toward the water to the south were found in the Village of Osterville.

***Craigville, Town of Barnstable (see Figure 4.3.4-1 for location of VP 7; Character photos in Figure 4.3.4-2, sheets 17-20)***

Craigville is located at the center of a large crescent-shaped sandy beach system bordered by headlands at Wianno in Osterville on the west and Squaw Island in Hyannis Port on the east. Open views of Nantucket Sound to the south are available from this large beach system. The busy shorefront area contains popular public, semi-private and private beaches and associated parking areas, as described in Section 5.3.3.4. The most open and extensive southerly views toward the water and the proposed action are from Craigville Beach, the bluff above the apex of Craigville Beach, and shorefront homes on Long Beach Road in Centerville.

The Craigville Historic District includes 33 buildings and one park within the larger village of Craigville. The southernmost boundary of the historic district is 0.25 miles (0.4 km) north and topographically low compared to the bluff overlooking Nantucket Sound, from which VP 7 was taken (see sheet 17; for locations see sheet 18.) The district is limited to the core of the original development of the earliest buildings associated with a camp meeting ground developed by the New England Convention of Christian Churches in the 1870s. Although most of the structures in the district are now privately owned summer homes, the Craigville Conference Center owns the Craigville Inn and runs religious retreats. The district is within the interior portions of Craigville, does not extend to the bluff above Craigville Beach, is well vegetated and has no open views of Nantucket Sound. Representative historic structures within the district are shown on sheet 20 (VP 7 CE-7 and CE-8). The structures on the bluff at VP 7 have not been determined eligible for listing on the NRHP.

The focus of the Craigville camp meeting ground was the Tabernacle, a simple wooden church constructed in 1887, at the head of a triangular shaped park. The Tabernacle is shown on sheet 20, VP 7-CE-8. The Craigville Historic District was determined to possess integrity of location, design, materials, workmanship and feeling, and meets criteria A and C of the NRHP. It was found to be significant for its association with the Christian camp meeting movement the 19$^{th}$ century, and contains a well-preserved collection of associated buildings (MHC, 1985).

The religious campground settlement was similar to other earlier Methodist camp meetings in Eastham, Yarmouth and Martha's Vineyard, and drew lay people and ministers who journeyed by train then carriage or barge for summer services. The architecture is very similar to the Yarmouth Camp Ground Historic District (MHC No. YAR.B), which is located in an interior wooded location just south of the mid-Cape Highway (Route 6) at Exit 7 and several miles north of Nantucket Sound. The Yarmouth Camp Ground Historic District also has no open views of Nantucket Sound.

***Other nearby areas visited but not selected for simulation***

The Centerville Historic District, which contains 49 buildings and one object along Main Street, does not offer ground-level views of Nantucket Sound toward the proposed action; representative character photographs of Centerville are provided on sheet 19.

***Hyannis Port, Town of Barnstable (see Figure 4.3.4-1 for location of VP 8; Character photos in Figure 4.3.4-2, sheets 21 through 30)***

The summer community in the Hyannis Port Historic District is characterized by large, well-maintained colonial and shingled Victorian beach homes. The district contains 127 buildings on 1,000 acres (4.0 km$^2$), and is roughly bounded by Massachusetts Avenue and Edgehill Road, Hyannis Avenue, Hyannis Harbor and Scudder Avenue. A representative historic structure is shown on sheet 21. Character photographs are shown on sheets 25 through 28; locations of the photographs are shown on sheets 22-24. Open views of the water to the south-southwest are available along the shorefront (see sheet 21, bottom photograph), and intervening structures and vegetation provide broken views from the road and near shore locations. Public access to the shoreline is very limited.

The Kennedy Compound is located along the shore within the Hyannis Port Historic District and is also represented by VP 8. The Compound was listed as a National Historic Landmark in 1972. The Compound contains approximately 6 acres (24, 300 $m^2$) of waterfront property on Nantucket Sound, and includes the white clapboard residences that formerly housed Kennedy family patriarch Joseph P. Kennedy and his sons Robert F. Kennedy and John F. Kennedy (U.S. Department of the Interior [USDOI], 1972). The largest is the Joseph P. Kennedy house, where the family summered starting in 1926, and where Rose Kennedy lived until her death in 1995. The smaller houses were purchased by the sons for their families, and together comprise the Kennedy Compound. The Compound was the base of John F. Kennedy's presidential campaign in 1960, and served as the Summer White House in 1961. Subsequent presidential summer stays were nearby at Squaw Island, which provided better security and privacy. Although the Compound itself was not visited during the field reconnaissance, observations from adjacent locations indicate that open views of the site of the proposed action would be available from the Kennedy Compound.

***Other nearby areas visited but not selected for simulation***

Other historic districts and properties visited during field reconnaissance in Hyannis, Yarmouth, Dennis, Harwich and Chatham are listed in Table 4.3.4-1. Locations are shown on Figure 4.3.4-1, and on the appropriate sheets in Figure 4.3.4-2. These locations either did not have open views of Nantucket Sound, or were not designated historic properties, and were therefore not selected for simulation.

***Monomoy Point Lighthouse, Town of Chatham (see Figure 4.3.4-1 for location of VP 26, Character photo in Figure 4.3.4-2, sheets 31-33)***

The Monomoy Point Lighthouse is located at the southern end of Monomoy Island, a coastal barrier beach island extending approximately 10 miles (16.1 km) south of the Cape's elbow at Chatham. The island is an uninhabited coastal dune and marsh complex, and comprises most of the Monomoy National Wildlife Refuge managed by the USFWS. The island is accessible only by boat, and little human disturbance or development is evident except for footpaths and the historic lighthouse and its associated buildings. The land form is characterized by rolling dunes and bluffs, with beach grass and sparse, scattered woody vegetation. Marshes and open water dominate views near the shoreline.

Wildlife such as gulls, terns and seals are abundant and add to the remote and undeveloped character of the island. The island is a National Wilderness Area, although the parcel that contains the lighthouse is not included in that designation. The MAS has owned the parcel since 1977. A lighthouse has occupied the site since 1823. The present light was constructed around 1871. The lighthouse complex is unmanned, and includes a brick light tower and a two-story keeper's house, both of which have deteriorated. The complex was determined significant in the areas of engineering, exploration and settlement, and transportation.

**North and East Sides of Martha's Vineyard**

***Oak Bluffs, Martha's Vineyard (see Figure 4.3.4-1 for location of VP 21, Character photographs Figure 4.3.4-2, sheets 45-50)***

This island village area is characterized by fairly high-density residential and commercial land use. Topography is relatively flat, except for a steep shoreline bluff. The lack of topographic relief and abundant structures tend to screen views toward the water from the interior of the area. The most open easterly-northeasterly views toward the proposed action are available along East Chop Avenue, Sea View Avenue and Ocean Avenue, as well as from residences along these roads, and from the East Chop Lighthouse. Ocean Park on Ocean Avenue (the selected viewpoint) also offers unobscured views toward the proposed action.

The VP 21 is representative of open views from East Chop Light and the Dr. Harrison A. Tucker Cottage at 65 (formerly 42) Ocean Avenue in Oak Bluffs, which are both listed on the NRHP.

The Tucker Cottage was originally built in the American Stick Style in 1872, and then was substantially altered into a large Queen Anne summer house in 1877. The house and carriage house is part of the Ocean Park neighborhood of large, late 19th century summer homes, near the Methodist camp meeting ground at Wesleyan Grove (see Martha's Vineyard Campground Historic District, below).

The street pattern of Ocean Park is a curvilinear series of narrow streets around Ocean Park, a 7 acre (0.03 $km^2$) semi-circular green space that faces Sea View Avenue and the Sound beyond. The Tucker Cottage overlooks the bandstand at Ocean Park on Ocean Avenue, the innermost crescent along the Park. The Dr. Harrison A. Tucker Cottage was determined to retain integrity of location, design, materials, workmanship, feeling, and association, and meets Criteria B and C of the NRHP (USDOI, 1990).

The East Chop Lighthouse is located on the highest bluff on East Chop, on the east side of Vineyard Haven Harbor. The cast-iron lighthouse was constructed in 1878, to replace a private lighthouse that was destroyed by fire. Open views toward the proposed action are available from this structure.

The West Chop Lighthouse, on the western side of Vineyard Haven Harbor, was originally constructed in 1817, replaced with the present brick tower in 1838, and was moved back from the sea in 1848 and 1891. Views toward the proposed action are screened by a line of white pines from roadside by the West Chop light, which is posted private property. Ground level views from the property itself are expected to be screened by the trees, although open views from atop the light are anticipated. Both East Chop and West Chop lighthouses have protected mariners entering Vineyard Haven Harbor since Colonial times, and both are listed on the NRHP's multiple listing of lighthouses on Martha's Vineyard.

***Other nearby areas visited but not selected for simulation***

Several other historic properties or districts in Oak Bluffs have more limited views of Nantucket Sound toward the area of the proposed action, due to screening provided by mature vegetation such as shade trees and intervening structures. These include the Martha's Vineyard Campground Historic District in Oak Bluffs (also called Wesleyan Grove), which contains 306 19th century cottages and 6 public buildings on 34 acres. The district is located close to, but does not border, Nantucket Sound. No ground level views of Nantucket Sound were found within this district. The campground was founded in 1835 as a summer Methodist meeting area; the first participants stayed in tents that were later replaced by small cottages. The focal points of the camp are the iron Tabernacle and the Trinity Methodist Church, both located on Trinity Park near the center of the campground. The typical campground cottage is a simple 1.5-story rectangular structure, approximately 15 ft (4.6 m) wide by 20 ft (6.1 m) deep. Porches, typically late 19th century additions, are heavily ornamented with trim. Much of the historic district is shaded with mature trees and other vegetation. The Martha's Vineyard Campground is significant for its unique architecture, state of preservation, and its association with 19th century religious practices (USDOI, 1978).

Religious activity in the 19th century caused the campground to grow rapidly. The original week-long religious meeting in August evolved as people began arriving earlier in the summer, sparking the resort development of the adjacent area. The resulting town of Cottage City was created in 1880, and was renamed Oak Bluffs in 1907.

The Oak Bluffs Christian Union Chapel (known as Union Chapel) is west of Ocean Park and close to the Methodist campground of Wesleyan Grove. The chapel was built in 1870 in the American Stick Style. The mature vegetation around the church partially obscures the chapel from contiguous streets, and fully screens the chapel from views of Nantucket Sound. The chapel exhibits integrity of location, design, materials, workmanship, feeling and association, and meets Criteria A and C of the NRHP (USDOI, 1990).

The Flying Horses Carousel at 33 Oak Bluffs Avenue is located in the business district of Oak Bluffs. It is listed on the NRHP, and has also been listed as a National Historic Landmark since 1987. The carousel of 20 prancing horses and four chariots has operated at this location since 1889, and is indicative of the late 19$^{th}$ century interest in amusements and recreation at summer resorts such as Oak Bluffs. The Flying Horses Carousel possesses integrity of location (since 1889), design, material, workmanship and association, and is significant as the oldest platform carousel operating in the United States (USDOI, 1979). No open views were available from this structure.

The Arcade at 31 (formerly 134) Circuit Avenue is a commercial building listed on the NRHP. No ground level views of the proposed action are available from this building, which is surrounded by other commercial buildings and shops along this busy street in downtown Oak Bluffs.

Limited views to the north-northeast are available from West Chop, a residential area in Tisbury. Views toward the site of the proposed action are not generally available from the center of Vineyard Haven.

***Edgartown, Martha's Vineyard (see Figure 4.3.4-1 for location of VP 20; Character photos Figure 4.3.4-2, sheets 38 through 44)***

This island colonial village area has relatively high-density residential and commercial land use, with well-maintained large homes, small shops, inns and restaurants connected by narrow streets. Public views toward the water from the village area are generally partially or fully screened by intervening structures and vegetation. Views toward the proposed action to the northeast are available from shoreline residences and associated private beaches. The only publicly accessible open northeasterly views are from Water Street and Lighthouse Beach. The selected viewpoint VP 20 is the most open view from a historic site (the Edgartown Lighthouse at the entrance to Edgartown Harbor). Almost all other views toward the site of the proposed action from Edgartown are partially blocked by Chappaquiddick Island.

The Edgartown Village Historic District comprises approximately 150 acres (0.6 km$^2$) along the west side of Edgartown Harbor. The district contains approximately 500 contributing buildings (constructed pre-1933), mostly wood frame houses of the 19$^{th}$ and early 20$^{th}$ centuries. A smaller, locally designated district (the Edgartown Local Historic District) is contained within the NRHP District. The village's two major periods of significance relate to late 18$^{th}$ to 19$^{th}$ century whaling activities, and late 19$^{th}$ century to present day summer tourism. Architectural styles vary from First Period Colonial (circa 1650's to 1750), late Georgian and Federal sea captains homes, Greek Revival, Victorian and Colonial Revival. The boundaries of the historic district do not extend to Nantucket Sound except at Edgartown Light (also called the Harbor Light Lighthouse), but views of the Sound to the east and northeast are available from easternmost structures within the district.

The Edgartown Lighthouse is located on a rock breakwater off a spit along the northeastern side of Edgartown Harbor. The original lighthouse at the eastern end of the Harbor was built in 1828 and destroyed following the Hurricane of 1938. This structure was replaced by a cast-iron lighthouse that originally stood at Crane's Beach in Ipswich, and was disassembled and moved by barge to Edgartown in 1939. The structure is part of the Lighthouses of Massachusetts multiple listing on the NRHP, and is one of five lighthouses included on the listing within Martha's Vineyard.

***Cape Poge, Edgartown, Martha's Vineyard (see Figure 4.3.4-1 for location of VP 19; Character photos in Figure 4.3.4-2, sheets 34-37)***

This largely natural area on the north side of Chappaquiddick Island is protected by the Massachusetts Trustees of Reservations, a private land and property conservation organization. The area contains dunes and low coastal vegetation, bordered in places by a steep 20 to 30 ft (6.1 to 9.1 m) high sandy bluff at the ocean shoreline. The area is undeveloped other than perhaps 5 to 10 large homes and several unimproved sand roads. Cape Poge offers expansive views at and near the shoreline. Once away from the shoreline, including at the base of the lighthouse discussed below, the dunes and dune vegetation effectively screen most views toward the water.

The Cape Poge Lighthouse at VP 19 is one of the five lighthouses on Martha's Vineyard listed on the NRHP. Built in 1922 on the northeastern tip of Chappaquiddick, the present wood-shingled lighthouse replaced several earlier decaying towers, the earliest of which was constructed in 1802. Encircling the top of the tower is a simple cast iron balustrade. The windows and doorway are pedimented.

**North Side of Nantucket**

Nantucket Village is a densely settled classic colonial New England maritime community on the western side of Nantucket Harbor. The entire island, including Muskeget and Tuckernuck Islands to the west, comprises a NRHP and was also designated as a National Historic Landmark in 1966. Muskeget Island was designated as a National Natural Landmark in 1980, as the only known locality where the Muskeget vole is found and the southernmost area where the gray seal breeds (National Registry of Natural Landmarks, 1999).

The historic character of the village is defined by the clean pious lines of the houses of former sailors, fishermen and clergy as well as the grand federal-style mansions of former ship captains and owners. These varied structures are linked by cobblestone streets and shaded with large street trees. Views of the northwest toward the site of the proposed action are not available at ground level within Nantucket village itself (although views may be available from the upper stories of some buildings) or from the docks and wharfs along the western side of Nantucket Harbor. Representative photographs of Nantucket Village and locations are provided on sheets 52-58. The simulation location is discussed below.

***Nantucket Cliffs along Cliff Road, North of Nantucket Village Center (see Figure 4.3.4-1 for location of VP 22; Character photos in Figure 4.3.4-2, sheets 51-58)***

Upon leaving the village area and heading to the northwest, narrow roads traverse a landscape of rolling dunes and low-density residential development. The dunes and vegetation tend to block views toward the water. An open area atop the shore-facing bluff along Cliff Road (the selected VP 22) offers the first open views toward the proposed action. The beach below also offers unobscured views. The beach continues to the west to the Eel Point conservation area at Madaket. Homes along the north shore and associated private beaches also have open views toward the proposed action, as does the shorefront area off Cliff Road to the east to Jetties Beach at West Jetty. Public access to the north-facing beaches is generally limited, and as one moves inland, views of the water toward the proposed action quickly disappear.

***Great Point, Nantucket (see Figure 4.3.4-1 for location of VP 23, Character photos in Figure 4.3.4-2, sheets 59 through 61)***

Great Point is a unique undeveloped beach area that forms the northeastern most part of Nantucket, and separates the Atlantic Ocean to the east from Nantucket Sound to the west. Characterized by crashing surf, rolling sand dunes, low beach grass and tidal marsh, the area is a remote and wild setting. The point is managed by the Trustees of Reservations, and is accessible only by four-wheel drive vehicle along a sand track. The Nantucket Light (also called Great Point Light or Sandy Point Light) and the immediately surrounding land constitute the historic property. Lighthouses have operated at Great Point since 1789. The existing unmanned masonry structure was constructed in 1818, and is one of the oldest existing lighthouse structures in the state.

Great Point Light was determined to possess integrity of location, design, setting, materials and workmanship, as well as significant associations with the development of aids to Massachusetts navigation. The tower is the first landfall on Nantucket seen from the Atlantic Ocean, and meets criteria A and C of the NRHP.

The Nantucket Conservation Foundation protects barrier beach south of the Great Point area. The area is remote and is characterized by ocean surf on the east, sand dunes and salt marshes. The area is largely undeveloped with only one or two private homes, a sand road, and the Great Point lighthouse, which is a visual focal point. Panoramic open views in all directions are available from many locations on Great Point, as well as along the sand access road, where not screened by sand dunes. The viewpoint from Great Point is representative of open views toward the proposed action from the Wauwinet area of Nantucket.

***Tuckernuck Island (see Figure 4.3.4-1 for location of VP 24, Character photos in Figure 4.3.4-2, sheets 62 through 64)***

Tuckernuck Island is roughly 2 miles (3.2 km) long and 1 mile (1.6 km) wide, and is located approximately 1 mile (1.6 km) west of Nantucket Island and 8 miles (12.9 km) east of Martha's Vineyard. This sparsely settled island off the western tip of Nantucket is accessible by boat only. The island is composed of moraine deposits (in the rocky northwestern portion of the island), sandy outwash plains along the south, and sand dunes.

The island contains about 30 to 40 seasonal cottages and larger homes, and a network of sand roads. The historic houses on Tuckernuck are clustered within two groupings, one around North Pond (on the northwest side of the island) and one around East Pond, and consist of wood-frame shingle-clad structures that generally reflect early fishing, hunting and livestock grazing economies. Topography is generally flat and vegetation consists of low to medium height shoreline scrub. Vegetation is taller and denser in the interior of the island, and more open and sparse near the shoreline. As a result of the level topography and scrub vegetation, views toward the proposed action are concentrated near the shoreline and from private residences.

**Additional Properties Analyzed for the FEIS**

In addition to the properties discussed above, twenty-two other properties were assessed based on comments from consulting parties. Of these, 18 were evaluated as eligible for inclusion in the NRHP. Each eligible property is described below, along with an assessment of the view from each property toward the proposed action. A summary of the view from these properties is presented in Table 4.3.4-1.

***Falmouth Heights Historic District, Falmouth (see Figure 4.3.4-3).***

The summer residential community of Falmouth Heights was the town's first planned summer resort community. Designed originally by noted Worcester architect Elbridge Boyden and developed between 1870 and 1930 on high bluff, the district includes approximately 500 properties, curvilinear streets, parks, and broad views of Vineyard Sound. The Falmouth Heights Historic District is entered in the MHC inventory as FAL.I and was previously determined eligible for the NRHP by the MHC. The Falmouth Heights Historic District is eligible for listing in the NRHP and meets criteria A and C.

The visibility of Nantucket Sound and the wind park site is unobstructed from the bluffs of the Falmouth Heights Historic District. It is approximately 3.5 miles northeast of VP-1, closer to the wind park, so turbines would be more visible from this historic property than from VP-1.

***Maravista Historic District, Falmouth (see Figure 4.3.4-3)***

The Maravista (meaning "view of the sea) area is defined by a cluster of approximately 25 well-preserved early 20$^{th}$ century summer cottages on Vineyard Sound that developed beginning in 1906 at one of the prime shoreline areas of Falmouth. The Maravista Historic District is entered in the MHC inventory as FAL.K and is potentially eligible for listing in the NRHP and meets criteria A and C.

Maravista Historic District is approximately 4 miles northeast of VP-1, so turbines would be more visible from this historic property than from VP-1. Views of Nantucket Sound and the wind park site are unobstructed from the shoreline areas of the district.

***Menahaunt Historic District, Falmouth (see Figure 4.3.4-3)***

The Menahunt (meaning "Island Place") area consists of approximately 25 well-preserved summer cottages from the 1870s and 1880s surrounded by coastal ponds and Vineyard Sound. The Menahaunt Historic District is entered in the MHC inventory as FAL.J and is potentially eligible for listing in the NRHP and meets criteria A and C.

Views of Nantucket Sound and the wind park site are unobstructed from the shoreline areas of the Menahaunt Historic District. The district is located approximately 6 miles northeast of VP-1; thus, turbines would appear larger on the horizon from this historic property than they would from VP-1.

***Church Street Historic District, Falmouth (see Figure 4.3.4-3)***

Located east of Little Harbor, the Church Street Historic District occupies the spit of land called Nobska Point, which contains Nobska Light (NRHP-Listed) at its highest point. The approximately 25 buildings range from the circa 1685 Abner Davis Tavern to the Church of the Messiah built in 1888, and large summer estates. The area was associated with 19$^{th}$ century shipping lanes and settlement at Woods Hole and later summer resort development. The Church Street Historic District is entered in the MHC inventory as FAL.M and is potentially eligible for listing in the NRHP and meets criteria A and C.

Views of Nantucket Sound and the wind park site are unobstructed from the Nobska Point bluff looking east, although most of the Church Street Historic District faces west towards Little Harbor. Views from this resource are represented by VP-1.

***Stage Harbor Lighthouse, Chatham (see Figure 4.3.4-3)***

Stage Harbor Lighthouse is located in low sand dunes and scrub growth at the southeast tip of Harding's Beach at the entrance to Stage Harbor. The intact complex consists of the cast iron lighthouse, erected and commissioned in 1880, attached shingle-clad keeper's house, boat shed, and outhouse in an undeveloped marine setting. The lantern and lens were removed when the light was decommissioned in

1935; otherwise the Stage Harbor Light remains essentially intact from the 19th century. Stage Harbor Lighthouse is entered in the MHC inventory as CHA.917 and was previously recommended as eligible for the NRHP. Stage Harbor Light is potentially eligible for listing in the NRHP and meets criteria A and C.

The Stage Harbor Lighthouse's location provides an unobstructed and panoramic view of Nantucket Sound and the location of the wind park. It is located approximately 4 miles east of VP-15, so the views of the wind turbines would be a little smaller and less visible than in VP-15 since atmospheric interference increases with distance.

***Captain Joshua Nickerson House, 190 Bridge Street, Chatham (see Figure 4.3.4-3)***

Set well back from the south side of Bridge Street on a knoll overlooking the Mitchell River, the Captain Joshua Nickerson House at 190 Bridge Street is a large and elegant two-story Federal period dwelling with a hip roof, rear wall chimneys, and a rear ell. The house was built about 1810 and has associations with 19th century Chatham's maritime history starting with retired sea Captain Joshua Nickerson, and with summer resort activities in the 20th century. The Captain Joshua Nickerson House is entered in the MHC inventory as CHA.260 and was previously recommended as eligible for the NRHP. The Captain Joshua Nickerson House is potentially eligible for listing in the NRHP and meets criteria A and C.

The Captain Joshua Nickerson House façade faces south; however, the intervening land mass of Stage Island obstructs views toward the site of the proposed action.

***Jonathan Higgins House, 300 Stage Neck Road, Chatham (see Figure 4.3.4-3)***

The Deacon Jonathan Higgins House at 300 Stage Neck Road is a traditional five-bay Cape Cod dwelling that was originally erected in Wellfleet about 1760. It was dismantled and re-assembled at its current site overlooking Oyster Pond River in 1939, under the guidance of architect George Forsyth, to be the summer home of Chief Justice Louis Brandeis of the U.S. Supreme Court. The Deacon Jonathan Higgins House is entered in the MHC inventory as CHA.419. The house is potentially eligible for inclusion in the NRHP for its associations with the Colonial Revival period in the early 20th century and meets NRHP criteria A and C. In 1999, the MHC requested additional information in order to determine eligibility.

There are no views towards the wind park site from the Deacon Jonathan Higgins House due to the land mass of Harding's Beach with lies between the house and Nantucket Sound.

***Stage Harbor Road Historic District, Chatham (see Figure 4.3.4-3)***

The Stage Harbor Road area extends from the Oyster Pond shoreline at Champlain Road northwards along Stage Harbor Road. A monument commemorates Samuel deChamplain's three week visit to Stage Harbor in 1606, which marked the first European exploration of the Chatham area. The approximately 50 properties in the area include Cape Cod cottages, Federal, Greek Revival, and Italianate style houses and barns that attest to the area's agricultural history and more importantly, it's connection to maritime industries and the sea in the 18th, 19th, and 20th centuries. The Stage Harbor Road area is entered in the MHC inventory as CHA.K and was previously recommended as eligible for the NRHP. The Stage Harbor Road Historic District is potentially eligible for listing in the NRHP and meets criteria A and C.

Due to the configuration of the Stage Harbor Road Historic District extending away from the shore and the presence of Harding's Beach and the Dike that create Stage Harbor, the visibility of the wind park site is limited to a narrow view through harbor mouth.

***Champlain Road Historic District, Chatham (see Figure 4.3.4-3)***

Approximately 25 historic Cape Cod and Greek Revival style cottages from the 18th through 20th centuries are positioned on a bluff along Champlain Road above Stage Harbor, where Samuel de Champlain anchored for three weeks in 1606. A yacht club and boatyard are set at the shoreline. The Champlain Road Historic District is entered in the MHC inventory as CHA.J. The Champlain Road Historic District is potentially eligible for listing in the NRHP and meets criteria A and C.

Views of Nantucket Sound and the wind park location beyond the intervening land spits that frame the entrance to Stage Harbor are experienced from the Champlain Road Historic District due to its relatively high elevation. The district is located approximately 4 miles east of VP-15, so the views of the wind turbines would be smaller and less visible than in VP-15 since atmospheric interference increases with distance.

***Hithe Cote, 32 Snow Inn Road, Harwich (see Figure 4.3.4-3)***

Stewart Church a doctor from Brooklyn New York built this two-story frame summer residence about 1890. Hithe Cote occupies the crest of a prominent hill above Vineyard Sound near Wychmere Harbor that was developed by Church and others as a summer resort. Hithe Cote is entered in the MHC inventory as HAR.211. The house is potentially eligible for inclusion in the NRHP and meets NRHP criteria A and C.

Although a more recent house has been constructed nearby, Hithe Cote's location continues to provide an unobstructed and panoramic view of Vineyard Sound and the location of the wind park. This view is represented by VP-15.

***Ocean Grove Historic District, Harwich (see Figure 4.3.4-3)***

Modestly-scaled and well-preserved Victorian cottages set along narrow streets characterize the Ocean Grove Historic District which began as a Spiritualist campground in the 1880s. In addition to approximately 100 houses, prominent topographical features include the Grove, which is formed in a natural bowl, and the Beach along Nantucket Sound. In the early 20th century use of the area shifted from Spiritualist gatherings to summer recreation, which continues today. The Ocean Grove Historic District is entered in the MHC inventory as HAR.L and was previously evaluated as eligible for the NRHP by the MHC. The Ocean Grove Historic District is eligible for listing in the NRHP and meets criteria A and C.

Open views of Nantucket Sound and the wind park location are present from the Ocean Grove Historic District properties and the beach along the shoreline. This resource is close to VP-15, so views to the project from this historic resource are represented by VP-15.

***205 South Street, Yarmouth (see Figure 4.3.4-3)***

The residence at 205 South Street is a three-quarter Cape Cod cottage built circa 1770. Its original site is unknown and it was apparently moved to its current location in the shore community near Bass River in the early to mid 20th century. Despite the move, which was not uncommon in that era, the house appears to be largely intact from the 18th century. 205 South Street is entered in the MHC inventory as YAR.365. The house is potentially eligible for inclusion in the NRHP and meets NRHP criteria A and C.

Views of Nantucket Sound and the location of the wind park are obstructed from 205 South Street.

***Park Avenue Historic District, Yarmouth (see Figure 4.3.4-3)***

The Park Avenue area includes approximately 25 modest summer residences from the late 19th and early 20th centuries. The district runs parallel to the water in a Lewis Bay shoreline resort neighborhood just west of Hyannis Inner Harbor. The area was not previously entered in the MHC inventory. The Park Avenue Historic District is potentially eligible for inclusion in the NRHP and meets NRHP criteria A and C.

Views of Nantucket Sound and the location of the wind park are present through the mouth of Lewis Bay. This resource is located approximately 2.5 miles northeast of VP-8, which approximates the view one might have through the mouth of Lewis Bay.

***Massachusetts Avenue Historic District, Yarmouth (see Figure 4.3.4-3)***

The Massachusetts Avenue area extends from the Lewis Bay shoreline northward away from the water and encompasses approximately 25 modest summer residences from the late 19$^{th}$ and early 20$^{th}$ centuries. The area was not previously entered in the MHC inventory. The Massachusetts Avenue Historic District is potentially eligible for inclusion in the NRHP and meets NRHP criteria A and C.

There are no views of Nantucket Sound and the location of the wind park due to the intervening presence of Great Island.

***Cottage City Historic District, Oak Bluffs (see Figure 4.3.4-3)***

Cottage City is a sprawling district of approximately 386 19$^{th}$ and 20$^{th}$ century summer cottages and houses, many of which are highly ornate, on the bluff overlooking Nantucket Sound. Two large focal parks, Central Park and Waban Park on the water, and several other parks are dispersed in the district. Cottage City is a local historic district and is entered in the MHC inventory on multiple area forms. The Cottage City Historic District is potentially eligible for inclusion in the NRHP and meets NRHP criteria A and C.

Views of Nantucket Sound and the location of the wind park are unobstructed from Cottage City, and are represented by VP-21.

***Vineyard Highlands, Oak Bluffs (see Figure 4.3.4-3)***

Vineyard Highlands was the third major area developed on Oak Bluffs, and was an effort in 1870 to establish a new camp meeting area with a wharf, hotel, and residences. Although development was slow, the area did emerge as a popular tourist and summer residence center by 1900. Curved streets, small parks, and approximately 300 cottages with a curving road along the high bluff at Nantucket Sound are defining characteristics. The Vineyard Highlands Historic District is entered in the MHC inventory as OAK.B. The Vineyard Highlands Historic District is potentially eligible for inclusion in the NRHP and meets NRHP criteria A and C.

Views of Nantucket Sound and the location of the wind park are unobstructed from the bluff of the Vineyard Highlands Historic District, and are represented by VP-21.

***Seaman's Reading Room, Tisbury (see Figure 4.3.4-3)***

The Seaman's Reading Room on West Chop Road/Main Street in Tisbury is a traditional Cape Cod cottage built about 1711 and is one of the oldest remaining houses on Martha's Vineyard. The house was moved from Hatch Road in 1918 and added on to in the 20$^{th}$ century. The Seaman's Reading Room is entered in the MHC inventory as TIS.135 and was determined eligible by consensus for individual listing in the NRHP.

There are no views of Nantucket Sound and the wind park from the Seaman's Reading Room due to intervening buildings.

***West Chop Historic District, Tisbury (see Figure 4.3.4-3)***

The West Chop Historic District, Tisbury, is an enclave of early 20th century Shingle style houses, club buildings, recreational facilities, and shore line beaches at the northern tip of West Chop in Nantucket Sound. The West Chop Historic District is entered in the MHC inventory as TIS.D and was listed in the NRHP in 2008. The West Chop Historic District meets NRHP criteria A and C.

There are panoramic views from West Chop eastward in Nantucket Sound to the wind park location. This resource is located approximately 2.5 miles northwest of VP-21, which provides a representative view from this district.

### *4.3.4.2 Visual Resources Associated with Tribal Areas of Cultural and Religious Importance*

The potential visual impact of the proposed action on the Wampanoag Tribe of Gay Head/Aquinnah and the Wampanoag Tribe of Mashpee, was raised as a concern during government-to-government consultations about the proposed action between the MMS and the Tribal Historic Preservation Offices.

At the Cape Wind public hearing at University of Massachusetts in Boston, the Chairwoman of the Wampanoag Tribe of Gay Head Aquinnah expressed concern that the right to practice their religious ceremony in the traditional manner will be forever denied by the proposed action. The Chairwoman stated "as the People of the First Light, one of the most important aspects and fundamental components of their religious and cultural beliefs and practices is their ability to experience, embrace, and give ceremony and prayers of thanksgiving to the first light. These ceremonies, spiritual and religious practices are dependent upon maintaining the ability to view the first light, the eastern horizon vista and viewshed. Additionally, there will be other impacts, such as the celestial and solstice ceremonies, which will also be adversely impacted." In a subsequent Section 106 Consultation meeting with the Gay Head/Aquinnah and Mashpee Wampanoag Tribes, Bettina Washington, Tribal Historic Preservation Officer for the Gay Head/Aquinnah, stated that by the alteration of their tribal members' ability to conduct their religious ceremonies with an unobstructed view of the rising sun on the eastern horizon, "... you're asking me to give up my identity."

At the Cape Wind public hearing in West Yarmouth, the Tribal Historic Preservation Officer of the Mashpee Wampanoag Tribe, Mr. George "Chuckie" Green Jr. stated, "historical, cultural, religious values that we place on the sound are immense. Our celestial ceremonies are held (on the sound). The blocking of those views, of that sunrise, would be an issue to the tribe." In addition, in their letter of comment on the DEIS, Mr. Green states, "The Mashpee are members of the Great Wampanoag Nation (the People of the First Light). Our name defines who we are…" The letter goes on to state that the Mashpee have a significant cultural and religious need to have a clear unobstructed view of the southeast horizon.

### *4.3.4.3 Visual Resources Associated With Recreational Areas*

Onshore Cape Cod, Nantucket, Martha's Vineyard (and the state waters of Nantucket Sound) are well known for coastal recreational and summer tourism activities including beach going, swimming, boating, fishing, hiking, biking, picnicking, golfing and bird watching. Marinas, yacht clubs and public boat ramps line most of the harbors and inlets with sufficient water depths. Large areas of undeveloped protected shoreline are found along Monomoy Island south of Chatham, Cape Poge on Chappaquiddick Island on Martha's Vineyard, and Tuckernuck Island and Great Point in Nantucket.

Sandy beaches nearly continuously rim the Cape and Islands landforms, supplied with sediments deposited by receding glaciers and reworked since then by fluvial processes (see Section 4.1.1). The shorelines around Nantucket Sound are generally developed with large seasonal shorefront homes or shorefront resorts and associated private beaches, most constructed during the 20th century. The public beaches attract thousands of recreational users in the summer months. Public and semi-private beaches (such as association and resident-only beaches) with expected open views toward the proposed action are shown on Figure 4.3.4-4. This figure also indicates the locations chosen for visual simulations. The names of the recreational areas shown in Figure 4.3.4-4 and their distance to the site of the proposed action are provided in Table 4.3.4-2. Identification numbers on the table and figure pertain to those resources identified by the MassGIS databases; resources identified by other information sources were placed on Table 4.3.4-2 in the rows between the nearest GIS-listed resources. Due to the generally level topography, mature wooded vegetation, and intervening structures found on the Cape and Islands, open views were generally limited to recreational areas in the immediate vicinity (i.e., within approximately 300 ft [91 m]) of the shoreline.

Note that all twelve visual simulation locations chosen for historical structures referenced in 4.3.4-1 (see Figure 4.3.4-2) are also in fact representative of recreational and or park areas, as the historic structure simulation locations were taken from nearby beaches and or at parks to allow for unobstructed, worst case visual impacts.

The following is a description of recreational areas that would have a view toward the site of the proposed action.

**South Side of Cape Cod**

***Nobska Point Light Station, Woods Hole, Falmouth (see Figure 4.3.4-1 for location of VP 1; Character photos in 4.3.4-2, sheets 1-7)***

Visitors to the historic lighthouse are presented with open views of Nantucket Sound from the southeast to the southwest, including views of Martha's Vineyard. The base of the light is publicly accessible, and a plaque provides historic information to visitors that park at a small adjacent lot. The surrounding area is residential, with large homes scattered along winding roads among low wooded hills. The popular Shining Sea Bike Path meanders through woods and along the shore near this area.

Heading easterly from Woods Hole to Cotuit (described below) are popular shorefront areas in Falmouth, and Falmouth Heights, as well as a number of small parks (see Table 4.3.4-2). The shoreline is nearly continuously rimmed with wide sandy beaches and contains large waterfront resorts, public beaches, and many seasonal homes with associated private beaches. These areas have open views of Nantucket Sound to the south.

***Cotuit, Town of Barnstable (see Figure 4.3.4-1 for location of VP 5; Character photos in Figure 4.3.4-2, sheets 8-11)***

Recreational resources in the vicinity of VP 5 are the Mashpee beaches, including South Beach State Park, the New Seabury beach, and Popponesset Beach, as well as Loop Beach in Cotuit. The New Seabury Country Club and golf course are also located in the vicinity of this viewpoint. The Waquoit Bay National Estuarine Research Reserve, a 3,000 acre (12.14 $km^2$) Area of Critical Environmental Concern (ACEC), bordering Falmouth and Mashpee, offers opportunities for passive recreation such as bird watching. Sampson Island, a 15 acre (6.1 hectare) MAS Sanctuary and barrier island at the mouth of Cotuit Harbor between Cotuit and Oyster Harbors, and many local sailing and boating programs are located within Cotuit and Osterville Harbors.

***Wianno (see Figure 4.3.4-1 for location of VP 6; Character photos in Figure 4.3.4-2, sheets 12-16)***

A small Town Beach with limited parking is located on Wianno Avenue at the eastern end of Sea View Avenue. Open views of the proposed action would be available from this location. Wianno Beach and the larger Dowses Beach in Osterville are also located in the vicinity of VP 6. Boating is a popular activity in the Osterville area, which includes a number of marinas.

***Craigville, Town of Barnstable (see Figure 4.3.4-1 for location of VP 7; Character photos in Figure 4.3.4-2, sheets 17-20)***

Craigville is located at the center of a large crescent-shaped sandy beach system bordered by headlands at Wianno on the west and Squaw Island in Hyannis Port on the east. Open views of Nantucket Sound to the south are available from this large beach system. The popular public beaches of Craigville Beach, the Association Beach, and Covell Beach are located in the vicinity of this viewpoint, as well as associated beach parking areas. Several summer rental cottage communities are located on the opposite side of Craigville Beach Road, with a popular snack bar servicing beach-goers in the summer months.

The private Beach Club on Long Beach Road in Centerville abuts the western end of the large Craigville Public Beach. Private beaches are located adjacent to large shorefront homes down Long Beach Road. The Long Beach Conservation Area, a 3.5 acre (14,100 $m^2$) protected barrier beach at the west end of Long Beach Road, offers passive recreation with limited parking.

***Hyannis Port, Town of Barnstable (see Figure 4.3.4-1 for location of VP 8; Character photos in Figure 4.3.4-2, sheets 21-30)***

Private recreational resources near this viewpoint include the Hyannis Port Golf Club and the Hyannis Port Yacht Club, which have open views of the water to the south. Public access to the shorefront is extremely limited.

Heading easterly along the shore from Hyannis Port to Chatham are the communities of Hyannis around Lewis Bay, including the boat and ferry docks of Hyannis, the Hyannis beaches of Keyes, Sea Street and Kalmus Park, the private residential Point Gammon area, and the beaches and recreational areas in West Yarmouth, Yarmouth, Bass River, West Dennis, Dennis, Dennisport, Harwich, Harwich Port, Wychmere Harbor, and Chatham. These are listed in Table 4.3.4-2, along with the distances and directions of the resource from the nearest viewpoints.

Open views of Nantucket Sound to the south-southwest are available from immediate shorelines of these areas, which include resorts and other accommodations, as well large seasonal homes and associated private beaches. Intervening topography, structures and vegetation typically screens views to the south and southwest from within Hyannis Inner Harbor and other smaller harbors to the east, such as Wychmere Harbor in Harwich Port.

***Monomoy Point Lighthouse, Town of Chatham (see Figure 4.3.4-1 for location of VP 24, Character photo in Figure 4.3.4-2, sheets 31-33)***

The 2,750 acre (11.12 $km^2$) island comprises most of the Monomoy National Wildlife Refuge managed by the USFWS and is a National Wilderness Area, although the parcel that contains the lighthouse is not included in the designation. Monomoy is only accessible by boat, and visitation at night is prohibited. The island offers opportunities for swimming and boating, as well as passive recreation, such as bird and wildlife watching.

VP 24 is also representative of the views from the beaches of Harwich and Chatham, and from Harding Beach boat landing.

**North and East Sides of Martha's Vineyard**

***Oak Bluffs, Martha's Vineyard (see Figure 4.3.4-1 for location of VP 21, Character photographs Figure 4.3.4-2, sheets 45-50)***

VP 21 at Ocean Park is also representative of open views from East Chop Light in Oak Bluffs. Ocean Park is a 7 acre (28,300 $m^2$) park overlooking Nantucket Sound, with a bandstand that offers musical and other outside entertainment. The East Chop Lighthouse is both a scenic and historic attraction.

The Flying Horses Carousel at 33 Oak Bluffs Avenue is located in the business district of Oak Bluffs. The carousel of 20 prancing horses and four chariots has operated at this location since 1889, and is a popular tourist attraction. No open views of Nantucket Sound are available from this structure.

VP 21 and VP 20 (below) are indicative of views from the bike path from Edgartown Beach Road between Oak Bluffs and Edgartown, and from beaches along this roadway. The viewpoints are also representative of views from Felix Neck Wildlife Sanctuary and Sarson's Island Bird Sanctuary, and the Farm Neck Golf Course.

***Edgartown, Martha's Vineyard (see Figure 4.3.4-1 for location of VP 20; Character photos Figure 4.3.4-2, sheets 38-44)***

Views at VP 20 are indicative of views at Lighthouse Beach and the Harbor Light Lighthouse, as well as recreational resources south of Oak Bluffs, as identified above.

***Cape Poge, Edgartown, Martha's Vineyard (see Figure 4.3.4-1 for location of VP 19; Character photos in Figure 4.3.4-2, sheets 34-37)***

This largely undeveloped area on the north side of Chappaquiddick Island is protected by the Massachusetts Trustees of Reservations. The area contains dunes and low coastal vegetation, bordered in places by a steep 20 to 30 ft (6.1 to 9.1 m) high sandy bluff at the shoreline. The Cape Poge Lighthouse is one of the five lighthouses on Martha's Vineyard listed on the NRHP. Built in 1922 on the northeastern tip of Chappaquiddick, the present wood-shingled lighthouse replaced several earlier decaying towers, the earliest of which was constructed in 1802.

A wide barrier beach open to the public extends to the south from Cape Poge Lighthouse. Several sand roads and a small number of large homes comprise the limited development. The Reservation offers expansive views across Nantucket Sound to the northeast, although once away from the shoreline (including at the base of the lighthouse), the dunes and association vegetation effectively limit most views of the water. Fishing is popular along the barrier beach at Cape Poge.

**North Side of Nantucket**

***Nantucket Cliffs along Cliff Road, North of Nantucket Village Center (see Figure 4.3.4-1 for location of VP 22; Character photos in Figure 4.3.4-2, sheets 51-58)***

An open area atop the shore-facing bluff along Cliff Road (the selected VP 22) offers the first open views toward the proposed action when coming from Nantucket Village. Cliff Beach below also offers unobscured views, and is representative of views continuing westerly to Dionis Beach, Capaum Beach and to the Eel Point conservation area at Madaket. Homes along the north shore and associated private beaches also have open views toward the proposed action, as does the shorefront area off Cliff Road to the east to Jetties Beach at West Jetty. Public access to the north-facing beaches is generally limited.

***Great Point, Nantucket (see Figure 4.3.4-1 for location of VP 23, Character photos in Figure 4.3.4-2, sheets 59-61)***

Great Point is a unique nearly pristine beach area that forms the northeastern most part of Nantucket, and separates the Atlantic Ocean to the east from Nantucket Sound to the west. The point is managed by the Trustees of Reservations, and is accessible only by four-wheel drive vehicle along a sand track out to Nantucket Light.

The Nantucket Conservation Foundation protects barrier beach south of the Great Point area. The area is remote, and is characterized by ocean surf on the east, sand dunes and salt marshes. The area is largely undeveloped, with only one or two private homes, a sand road, and the Great Point lighthouse, which is a visual focal point. Panoramic open views in all directions are available from many locations on Great Point, as well as along the sand access road, where not screened by sand dunes. Beaches include Coskata Beach and Coatue Beach. The area offers opportunities for passive recreation.

***Tuckernuck Island (see Figure 4.3.4-1 for location of VP 24, Character photos in Figure 4.3.4-2, sheets 62-64)***

This island has several colonies of seasonal houses. No recreational resources available to the public were identified on the island itself.

#### *4.3.4.4 On-shore Cable Route*

Since the cable route would be located beneath public roadways or within the existing NSTAR easement, no historic properties listed or eligible for listing on the NRHP are located within the proposed action's Area of Potential Effect (APE) for ground disturbance along the onshore route. There are over 30 recorded buildings in the hamlets of West Yarmouth and Englewood in the vicinity of the landfall, which are included in MHC's Inventory. While not considered a historic district, a number of these buildings date from the early 1700s to late 1800s and are documented as belonging to sea captains or other wealthy residents of Yarmouth. The buildings are arranged in three clusters in Englewood. There are no other historic structures recorded along the route northward to the NSTAR ROW.

Two historic buildings and an historic cemetery are located in Barnstable, approximately 0.25 to 0.75 miles (0.4 to 1.2 km) north of the cable route along the NSTAR ROW. Both historic buildings are off Marstons Lane; the cemetery is located on Mary Dunn Road.

### 4.3.5 Cultural Resources

For the purposes of this analysis, the term "Archaeological Resources" refers to deposits of material remains of past human cultural activities, both historic and prehistoric, whether onshore or offshore. "Above-ground Historic Resources" will be used for onshore historical structures, districts and landscapes, and the term "Historic Archaeological Resources" will be used for onshore deposits of historic material that are at the ground surface and below.

#### *4.3.5.1 Onshore Cultural Resources*

##### 4.3.5.1.1 Historic

An APE for a project is defined as that geographic area or areas within which construction/decommissioning, operation or maintenance of a project may directly or indirectly cause alterations in the character or use of historic properties [36 CFR Part 800 Section 16(d)].

The APE for the onshore component of the proposed action includes areas of physical ground disturbance during construction/decommissioning, operation and maintenance, such as the construction areas along the overland route to the tie-in at the Barnstable Switching Station, as well as those areas within view of the proposed action (such as those historic properties on Cape Cod, Martha's Vineyard, and Nantucket from which open views of the visible components of the proposed action (aboveground or above water) would be available.

**Historic Archaeological**

Through consultation with the MHC, an archaeological survey was conducted to identify any historic archaeological sites that may be located within the proposed action's APE (Report No. 4.3.5-1). No on-shore historic archaeological sites were identified in the proposed action's APE. In a letter dated April 22, 2004, MHC accepted these recommendations that no on-shore historic archaeological sites would be impacted by requesting an additional copy of the final report.

**Above Ground Historic Resources**

Given the proposed location of the onshore electric transmission cable system underground beneath existing public roads and the NSTAR ROW, there are no physical impacts to historic structures, and the APE for visual effects focused on potential views of the offshore proposed action. Due to the generally level topography, mature wooded vegetation, and intervening structures found on the Cape and Islands, it was found during field reconnaissance that open views were generally limited to historic resources in the immediate vicinity (within approximately 300 ft [91 m]) of the shoreline).

Known historic resources in communities within potential visual range of the offshore turbines were compiled based upon a review of available databases and records at MHC. Historic structures and districts were identified in the Towns of Barnstable, Falmouth, Yarmouth, Dennis, Harwich, Chatham, Nantucket, Oak Bluffs, Tisbury and Edgartown. Subsequent to publication of the DEIS, interested parties provided MMS with a list of 22 additional properties that were evaluated for NRHP eligibility and potential project impacts. Interested parties also provided a list of eight properties located in the Town of Yarmouth, five of which are within the South Yarmouth/Bass River Historic District, expressing concern that these properties potentially were within view of the proposed action. Field visits were conducted for these properties, but none has a view of the proposed action. It also was determined that no properties within the District have a view of the proposed action. Therefore, because these properties are outside of the project's APE, they were not evaluated for NRHP eligibility.

The initial inventory of historic resources within the APE followed the USACE guidance, and included only properties that were already listed on the NRHP. In response to comments received on the proposed action, the inventory was expanded to include properties included in MHC's Inventory of Historic and Archaeological Assets of the Commonwealth, along with other properties noted in public comments (e.g., Ritter House and William Street Historic District on Martha's Vineyard).

Twenty-two existing historic structures and districts listed or eligible for listing on the NRHP that may potentially be visually affected by the built proposed action were identified within the proposed action's APE on Cape Cod, Martha's Vineyard, and Nantucket prior to publication of the DEIS. Based on information received after publication of the DEIS, 22 additional properties were assessed (18 of which are considered eligible for the NRHP and four that are not eligible for inclusion in the NRHP). A detailed description of these historic structures and districts and their visual resources is provided in Section 4.3.4.

#### 4.3.5.1.2 Prehistoric

Through consultation with the MHC, an archaeological survey was conducted to identify any prehistoric archaeological sites that may be located within the proposed action's APE along the onshore portion of the transmission cable route (Report No. 4.3.5-1). No onshore prehistoric archaeological sites were identified in the proposed action's APE. In a letter dated April 22, 2004, the MHC requested a copy of the final report.

#### 4.3.5.1.3 Tribal Areas of Traditional Cultural and Religious Importance

Indian lands belonging to two groups of the Wampanoag Indians are located somewhat in the vicinity of the proposed action: One in Aquinnah (Gay Head) on the western end of the island of Martha's Vineyard in Dukes County, and one in Mashpee, in Barnstable County, Massachusetts.

**Wampanoag Tribe of Gay Head (WTGHA)**

In 1972 the Wampanoag Tribal Council of Gay Head, Inc., was formed to promote self-determination, to ensure preservation and continuation of Wampanoag history and culture, to achieve Federal recognition for the tribe, and to seek the return of tribal lands to the Wampanoag people. The WTGHA became a federally acknowledged tribe on February 10, 1987 through the Bureau of Indian Affairs (BIA). The WTGHA is governed by a popularly elected representative Tribal Council.

As of February 2005, the WTGHA had a population of approximately 1,100 members enrolled. Approximately 68 live on tribal lands in the Town of Aquinnah and 298 live within the Tribe's service area (Dukes County) (WTGHA, 2008). The Tribe owns approximately 485 acres (1.96 $km^2$) of land, including approximately 160 acres (0.65 $km^2$) of private and 325 acres (1.31 $km^2$) of common lands (MWT, 2008).

Maintaining and protecting tribal cultural resources is a top priority of the WTGHA. The Tribe is currently in the process of developing a Cultural Resource Protection Program that would incorporate the Tribe's responsibilities under the NHPA, the Archaeological Resource Protection Act (ARPA) and the Native American Graves Protection and Repatriation Act (NAGPRA).

Enterprises run by the WTGHA include several stores that sell tribal merchandise and the operation of a shellfish hatchery. The tribe also uses Vineyard Sound and surrounding waters for subsistence fishing.

The WTGHA are descendants of Wampanoag people who traditionally inhabited the southeastern portion of present day Massachusetts, including Cape Cod, eastern Rhode Island and Martha's Vineyard since at least the late 15$^{th}$ century. Of eastern Algonquin linguistic stock, the Wampanoag were referred to as Pokanoket in early documents describing Native Americans in the area. A horticultural people, during the early 17$^{th}$ century, the Wampanoag occupied approximately 30 villages in this region. Best known in the literature for their relationship with the Plymouth Pilgrims, the Wampanoag's leader, Massasoit, welcomed the English and remained at peace with them until his death in 1661. By that time the Wampanoag had suffered grave population losses due to the introduction of epidemic causing disease and the usurpation of much of their ancestral land. The Wampanoag Nation was established in 1928 through the involvement of the two Mashpee men, Eben Queppish and Nelson Simons, in the Pan-Indian movement in the early part of this century.
(http://www.eda.gov/ImageCache/EDAPublic/documents/pdfdocs/22massachusettes_2epdf/v1/22massachusettes.pdf)

Cheryl Maltais, Chairwoman of the Wampanoag Tribe of Massachusetts stated in the public hearing held on March 13, 2008 at the University of Massachusetts that, "the Wampanoag Tribe of Gay Head (Aquinnah) is a member tribe of the Great Nation of the Wampanoag People, they are known as the People of the First Light. The name defines who they are and differentiates them from all other tribal nations. Their name and its definition are the cultural and spiritual identity and the essence of who they are. Since time immemorial the Wampanoag people have inhabited the area of the easternmost lands and waters and have maintained their traditional spiritual and cultural connection to them." An unobstructed view of the southeastern horizon from the locations used for the practice of their traditional religious beliefs is sacred to the Wampanoag.

**Wampanoag Indian Reservation in Mashpee**

The Mashpee Wampanoag Tribe was federally acknowledged on February 15$^{th}$, 2007 (BIA, 2007). The tribal membership is approximately 1,530 members, of whom over half live in Barnstable County. The Tribe has approximately 140 acres (0.57 $km^2$) of tribally owned land in the town of Mashpee, Barnstable County, as well as approximately 540 acres (2.18 $km^2$) in the town of Middleboro in Plymouth County (73 Fed. Reg. No. 35, March 6, 2008). The Mashpee Wampanoag Tribal lands in Barnstable County are located in the town of Mashpee on the western end of Cape Cod. It is common land owned by the tribe and serves as the tribe's land base. The tribal building is located off Great Neck Road in the town of Mashpee.

The Wampanoag Indians of Mashpee were the first to greet the pilgrims in 1620 and played host to them in the first Thanksgiving in 1621. Since that historic period, the Mashpee Wampanoag have served their tribal community and their fellow citizens in the town of Mashpee, the Commonwealth of Massachusetts, and the United States of America as neighbors and friends. Today, the Mashpee (whose name evolved from the aboriginal name Massippie, meaning "Land of the Great Cove") have the largest native population in Massachusetts. With approximately 1,500 members, the tribe has lived on its native homeland since at least the time of European contact in the early 16$^{th}$ century. The Mashpee pride themselves in honoring a heritage that pre-dates American Independence by 125 years (MWT, 2008).

In their letter of comment on the DEIS, George "Chuckie" Green, Jr., Tribal Historic Preservation Officer for the Mashpee Wampanoag Tribe, states, "The Mashpee are members of the Great Wampanoag Nation (the People of the First Light). Our name defines who we are ...." The letter goes on to state that the Mashpee have a significant cultural and religious need to have a clear unobstructed view of the southeast horizon.

### *4.3.5.2 Offshore Cultural Resources*

The APE for offshore archaeological resources includes the footprints of the WTG structures on the sea bottom; the work area around each WTG where marine sediments may be disturbed; the jet plowed trenches for installation of the inner-array cables connecting the WTGs to the ESP; the jet plowed trenches for the transmission cable system from the ESP to the landfall, and associated marine work areas such as anchor drop areas.

A marine sensitivity assessment of approximately 15,360 acre (62.15 $km^2$) of Nantucket Sound seafloor comprising the proposed action study area, as well as along the 115 kV transmission cable system route to the Yarmouth landfall, was conducted in 2003 (Report No. 4.3.5-2). Based on this assessment, a marine archaeological reconnaissance survey was conducted in the offshore study area in 2003 (Report No. 4.3.5-3). A follow-up marine archaeological reconnaissance survey was performed once the WTG array was revised (Report No. 4.3.5-4).

#### 4.3.5.2.1 Historic

The Marine Archaeological Sensitivity Assessment conducted for the proposed action by PAL (Report No. 4.3.5-2) indicated that there were 45 ships reported lost within the general vicinity of the project area. The dates of the vessels lost range from 1841 to 1963; however 19 of the vessels had no date of loss given in the source databases used by PAL. The primary sources of shipwreck data used in the PAL analysis were the Massachusetts Board of Underwater Archaeological Research (MBUAR), the

Northern Shipwreck Database, and the NOAA Automated Wreck and Obstruction Information System (AWOIS) database. A listing of these reported shipwrecks is found in Appendix A of PAL's report (Report No. 4.3.5-2).

A subsequent compilation of reported shipwreck losses by J.F. Jenney (Jenney, 2007) produced a list of 95 shipwrecks reported lost in the general vicinity of the project area; the dates of loss ranging from 1744 to 1990. The sources used by Jenney included those used by PAL, as well as local sources of information such as newspapers and family genealogical reports. Only 13 vessels could be directly correlated by name between the PAL report and the list compiled by Jenney. This discrepancy is probably due in large part to the additional primary sources used in compiling Jenney's list. Compilation of shipwreck data is very problematic, and there are many additional reasons that such discrepancies may exist between shipwreck listings for a given area (e.g., the extent of the geographic area included in the search; uncertainty about the exact location of loss; multiple listings for the same ship with variations in the details given, including alternate spellings of the vessel name; listings indicated as unidentified vessel, or unidentified date of sinking; and listings of obstructions that may be shipwrecks, but which have not been verified). Other considerations in relating lists of shipwreck losses to actual shipwreck sites within a given geographic area are that some vessels were burned or otherwise destroyed, and many were salvaged with no record of the salvage having taken place.

In addition to the potential for historic period shipwrecks, it should be noted that a local researcher, Mr. Neil Good of Mashpee, has been investigating the potential for early Viking contact sites in the Nantucket Sound area. Norse sagas describe a settlement (Vineland) founded by Leif Ericson on the east coast of North America. In the 1960s an early European settlement (ca. A.D. 1000) was found outside of L'Anse aux Meadows, Newfoundland; however, many researchers do not believe this site represents Vineland because of inconsistencies in the description of the location and environment of Vineland in the Norse sagas compared to that of the site in Newfoundland. According to Mr. Good, over 30 scholars have placed Vineland on or near Cape Cod, with many favoring sites in the immediate vicinity of Nantucket Sound. Mr. Good is presently focusing his research efforts on Waquoit Bay, approximately 6.5 miles west-northwest of the proposed project area on the south side of Cape Cod.

A marine archaeological survey was completed in June and July 2003 by PAL in water depths greater than 3 ft to locate any evidence of potential archaeological sites within the offshore portion of the proposed project area. This survey recorded 154 magnetic anomalies and 109 side-scan sonar contacts. Of the 263 magnetic anomalies, and side-scan sonar contacts all but 29 were determined to have a source that was non-cultural in nature or was interpreted as isolated debris, and, therefore, were eliminated from further consideration. Survey data for the remaining 29 anomalies were post-processed and additional analyses were completed.

Analyses of the post-processed data associated with the 29 anomalies of interest and additional data collected during September 2003 produced three targets with moderate probability of representing historic period submerged cultural resources. All are in the vicinity of Horseshoe Shoal. Locations were provided to MHC and the Massachusetts MBUAR, but are not publicly distributed to protect the integrity of these potential sites.

#### 4.3.5.2.2 Prehistoric

A marine archaeological sensitivity assessment and a marine archaeological reconnaissance survey indicate that a majority of the offshore study area has a low probability for containing submerged prehistoric archaeological resources. However, it also concluded that prehistoric archaeological deposits with contextual integrity might be present within limited parts of the eastern offshore study area where former natural soil strata (paleosols) may be present. Some of these areas occur in the location proposed for the proposed action. The turbine array has been adjusted to avoid these potential prehistoric site areas.

#### 4.3.5.2.3 Tribal Areas of Traditional Cultural and Religious Importance

The Wampanoag consider the entirety of Nantucket Sound to be ancestral lands, based on their oral traditions. This area, as well as a vast extent of the entire continental shelf was exposed as dry land during the late Wisconsinan glacial period (ca. 19,000 to 3000 B.P.). In their letter of comment on the DEIS, George "Chuckie" Green, Jr., Tribal Historic Preservation Officer for the Mashpee Wampanoag Tribe, states, "The Wampanoag people have inhabited the land from the western shore of Narragansett Bay to the Neponset estuaries since time immemorial, even the land now called Horseshoe Shoals. Our oral traditions tell us this land was walked and lived on by our ancestors."

## 4.3.6 Recreation and Tourism

### *4.3.6.1 General Information on Recreation and Tourism*

Cape Cod and the Islands receive a large percentage of their revenue from the tourism industry. The focus of most area tourism is the high quality recreational activities the area offers. The Cape Cod Chamber of Commerce estimates that approximately 44 percent of the economic base for Cape Cod comes from seasonal tourism. An estimated six million tourists visit Cape Cod annually, spending nearly one billion dollars. Almost two-thirds of these visitors vacation during the summer and fall seasons. Tourism on the Cape and Islands includes recreational activities such as: beach going, fishing, boating (including windsurfing and jet skiing), boat racing, golfing, hiking, picnicking, sightseeing (light houses and other historic areas, etc.), and shopping. Guided tours or charters are available for many of these activities including fishing; whale watching; wildlife, kayaking, canoeing tours, and bike tours.

Beaches that are within the viewshed of the area of the proposed action are located in the towns of Falmouth, Mashpee, Chatham, Harwich, Dennis, Yarmouth, Edgartown, Oak Bluffs, Barnstable, Tisbury, and Nantucket. Detailed estimates of the annual number of beachgoers are not available. However, using data from those towns who responded to inquiries of the number of beach stickers issued to residents and non-residents as an indicator (over 33,000 stickers between Mashpee, Chatham and Yarmouth alone) suggest that beachgoers within the viewshed number in the hundreds of thousands. A complete listing of beaches is provided in the Table 4.3.4-2 of the visual impact section.

The construction of the onshore transmission cable system may temporarily affect the parking lot to a recreational resource at Englewood Beach, off of New Hampshire Avenue. However, any impact to this onshore recreational resource is expected to be minimal and limited to off-season beach visitors due to the onshore construction timeframe (Labor Day through Memorial Day).

The near shore and offshore waters of Nantucket Sound were also identified as important recreational resources and therefore economically valuable tourist attractions. The site of the proposed action is centrally located within Nantucket Sound. Peak recreational activity is during the warmer months of the year (typically April through October), corresponding with the peak tourist season.

Recreational users such as fishermen, windsurfers, swimmers, water skiers, jet skiers, and other boaters are active along the near shore and shoreline areas facing Nantucket Sound. Scuba diving is limited in the area because the soft sediment habitat is generally uninteresting. The offshore waters are used by larger power and sailboats.

#### *4.3.6.2 Birding*

Several locations on Cape Cod and the Islands focus on bird watching as a recreational activity. These include MAS's Felix Neck and Wellfleet Bay Wildlife Sanctuaries, Monomoy National Wildlife Refuge, and Cape Pogue Wildlife Refuge. In addition, the Cape Cod Museum of Natural History, and the Cape Cod Bird Club are organizations active in bird watching. The vast majority of birding takes place on shore. Birding that takes place offshore in Nantucket Sound is close to shore. MAS runs some trips in the vicinity of Monomoy National Wildlife Refuge and there are kayaking tours around Cape Poge.

#### *4.3.6.3 Federal or State Parklands and Reserves*

Information regarding Federal or State Parklands and Reserves is provided in Section 4.3.4 along with a map showing these locations relative to the site of the proposed action. Table 4.3.4-2 provides a breakdown of Federal or State Parklands and reserves in the area, their distance to the site, and reference to visual simulations from these areas or nearby representative locations.

#### *4.3.6.4 Beach and Shoreline Activities*

Onshore Cape Cod, Nantucket, Martha's Vineyard (and the State waters of Nantucket Sound) are well known for coastal recreational and summer tourism activities including beach going, swimming, boating, fishing, hiking, biking, picnicking, golfing, and bird watching. Marinas, yacht clubs and public boat ramps line most of the harbors and inlets with sufficient water depths.

Sandy beaches nearly continuously rim the Cape and Islands landforms, supplied with sediments deposited by receding glaciers and reworked since then by fluvial and coastal processes (see Section 4.1.1). The shorelines around Nantucket Sound are generally developed with large seasonal shorefront homes or shorefront resorts and associated private beaches, most constructed during the 20th century. The public beaches attract thousands of recreational users in the summer months. Public and semi-private beaches (such as association and resident-only beaches) with expected open views toward the proposed action are listed on Table 4.3.4-2, as are conservation areas and other recreational resources such as golf courses and bike paths with expected open views toward the proposed action. Visual simulation locations from representative historic sites are provided in the tables for each resource, to capture a sense of the overall anticipated visual change at the recreational area due to the proposed action. Due to the generally level topography, mature wooded vegetation, and intervening structures found on the Cape and Islands, open views were generally limited to recreational areas in the immediate vicinity (i.e., within approximately 300 ft [91 m]) of the shoreline. Recreational resources identified from the MassGIS database are shown on Figure 4.3.4-3.

#### *4.3.6.5 Recreational Boating and Water Activities*

Boating on Nantucket Sound consists of a mix of commercial and recreational activity. Commercial activity includes passenger ferries, vessels, and barges carrying liquid and dry bulk goods, occasional cruise ship visits, commercial fishing vessels, charter fishing vessels, and research activity. Recreational activity includes fishing, sailing, cruising, boat racing, jet skiing, kayaking, and canoeing.

Recreational traffic in the Sound is seasonal with the summer months from June to October seeing a dramatic increase in water activities by recreational traffic both by boats that originate from the area marinas as well as recreational craft that visit the area from the entire New England and Mid Atlantic Region.

Nantucket Sound is a well known area that attracts all types of recreational craft from the smallest runabout to very large yachts; it is a very desirable location for yachtsman, with destinations on both Islands and the Cape Cod shore. These yachts not only include world class power boats/cruisers privately or corporately owned (*Lone Ranger Length 254 ft [77 m]/Acquisition 121 ft [37 m]*) but also sail boats of all sizes (*Southern Cross Maxi 88*). Many remain in the region for the entire boating season, while others use the area to transit to other ports of call along the New England and Mid Atlantic Coasts as well as Canada.

Coastwise and recreational vessels tend to use the Main Channel (south of Horseshoe Shoal) when transiting Nantucket Sound for points within Nantucket Sound and for the Atlantic Ocean. The Main Channel also serves as an inside passage for medium draft vessels to avoid Nantucket Shoals (south and east of Nantucket in the Atlantic Ocean). This channel is marked with aids-to-navigation, and has a minimum depth of approximately 30 ft (9.1 m) MLLW. However, the drafts of vessels using the Main Channel seldom exceed 24 ft (7.3 m) MLLW (NOAA, 2008).

The North Channel (north of Horseshoe Shoal) is used by vessels bound for the Cape Cod shore and by vessels transiting the Sound during northerly winds. This channel is marked with aids-to-navigation, and has a minimum depth of approximately 16 ft (4.9 m) (NOAA, 1994).

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 to 45 ft (13.7 m) at MLLW, with the majority of the shoal covered by between 20 ft and 30 ft (6.1 and 9.1 m) of water at MLLW. As a result, larger vessels avoid Horseshoe Shoal and stay in the Main Channel and the North Channel. Changes in water depths over short distances and strong tidal currents (with peak currents often exceeding 2 knots [1 m/s]) also tend to create steep waves that break on the shoals, causing many shallow-draft boaters to avoid the shoals. In addition, the long distance from shore and the wave and tidal action also limit use by very small recreational vessels, such as open runabouts.

Recreational boating use data are available based on 53 total days of proposed action related field work during the summers of 2001, 2002 and 2003. According to this information, recreational vessels observed during the summer (Memorial Day through Labor Day) within the proposed action area at Horseshoe Shoal ranged from no vessels observed (30 percent of the field days) to 11 vessels observed (in one day). Using these field observations the estimated median number of recreational vessels observed daily is two.

To supplement these field observations, observations were made from the SMDS platform of vessel movements on and around Horseshoe Shoal over three summer weekend days (Saturday, June 12, 2004; Sunday, June 13, 2004; and Saturday, July 3, 2004) when recreational boating activities are generally at their highest. Weather conditions were clear and conducive to recreational boating. These observations involved visually scanning the Horseshoe Shoal area and the Main Channel at intervals of approximately 15 minutes to count the number of vessels observed. Vessels observed were characterized as being either on Horseshoe Shoal or in the Main Channel.[18] Approximately 81 percent of the vessels observed were recreational vessels, and approximately 57 percent of the vessels observed were operating in the Main Channel. Recreational vessels observed on Horseshoe Shoal on these days ranged from no vessels observed in a 15 minute period to 12 vessels observed. On average, approximately 2 recreational vessels and/or one commercial vessel were observed during each 15 minute period. Additional information and discussion of boating activities is included in Section 4.4.3 of this document.

[18] For the purposes of the observations, the boundaries of Horseshoe Shoal were Buoy N2 to the west, bell buoy G5 to the north, the ferry route to the east, and the Main Channel to the south. This study area encompasses approximately 51 square miles and is significantly larger than the area of the proposed action.

### *4.3.6.6 Recreational Fishing*

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. Details on recreational fishing statistics and fish caught are discussed in Section 4.2.7.2.2.

## 4.3.7 Competing Uses in the Vicinity of the Proposed Action

In addition to the proposed action, other activities in the past, present or future which may contribute to competing uses of OCS space and would include submarine transmission cable or pipeline installations and bottom founded structures, navigational features, sand mining and mineral extraction, commercial and recreational fishing and boating, military training, and other OCS alternative energy development. The following section describes the potential competing uses of the proposed action (i.e., the space use conflicts of the proposed action) on each type of use.

### *4.3.7.1 Pipelines and Cables*

Presently, there are three existing submarine transmission 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 locus. The other two submarine transmission cable systems connect the mainland transmission system from Harwich and Barnstable (Lewis Bay) to Nantucket Island located approximately 8 miles (13 km) east of the proposed action 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 transmission 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 transmission cable system installations in Nantucket Sound except for those associated with the proposed action.

Other large offshore projects that could potentially be constructed in the future include two Liquefied Natural Gas (LNG) projects with submarine and upland gas pipelines that have been proposed by Excelerate and Neptune Energy. These projects are located in Massachusetts Bay north of Cape Cod and far from the site of the proposed action and could not be considered competing uses.

### *4.3.7.2 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. The 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 MV, and passes south of Hedge Fence shoal. It then continues in a Southeasterly direction passing between Horseshoe Shoals to the North, and Hawes Shoal (Chappaquiddick Island) to the South. The channel is fairly wide in most areas being approximately 1.15 miles (1.9 km) across from edge to edge as marked on NOAA Chart 13237 for a draft of 30 ft (9.1 m). It constricts down to approximately 0.86 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 1 mile (1.6 km) in width. The Main Channel continues and turns East North East and then North East 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 ft (7.3 m) (NOAA, 2008).

- 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) MLLW.
- This channel is used mostly by vessels bound for the south shore of Cape Cod, and by vessels transiting the Sound during northerly winds.

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 4.3.7-1).

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 proposed action vicinity. Hyannis Harbor was dredged in 1985, 1991, and 1998. No future dredging activities are currently scheduled. However, any future USACE maintenance dredging in Hyannis Harbor would most likely be the subject of additional environmental assessment.

Quonset Point, which would be used for construction staging, assembly and loading of supplies onto marine vessels is an existing industrial port and equipped to handle the requirements of the proposed action during construction and decommissioning. Channel depth is sufficient for large vessels to dock in the vicinity of the area and such work would not interfere or compete with an existing use at the Quonset Point area.

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

#### 4.3.7.3 Sand Mining and Mineral Extraction

Presently, there are no sand mining projects proposed within the site of the proposed action that would cause space use conflicts; however, the demand for sand to nourish eroding beaches has risen in recent years and would be expected to increase given the rising sea levels and eroding shorelines. For example, there is currently one proposal for an offshore sand mining project in the vicinity of Nantucket Sound. The Sconset Beach Nourishment Project is proposing a 345 acre (1.4 $km^2$) dredge site approximately 3 miles (4.8 km) east of Nantucket Island just outside the CIOS. The Sconset Beach Nourishment Project is under MEPA review and is contingent upon approval and licensing from several other state and Federal agencies including MMS and the USACE.

There is a current moratorium on oil and gas drilling off of the Atlantic coast with extended protections set to last until 2012.

### 4.3.7.4 Commercial Fishing and Boating

In response to comments on the draft EIS prepared by the USACE from the MDMF, NOAA Fisheries, and the Massachusetts Office of CZM, the applicant conducted a survey of recreational and commercial fishing activities (Report No. 4.2.5-6). The 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.

As discussed in Section 4.4.3.9, 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 indicate 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, Massachusetts 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 ft (18.2 to 30.5 m) 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 as previously discussed in Section 4.3.7.2 and as shown in Figure 4.3.7-1, which depicts main ferry routes in the area. 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 1 to 45 ft (0.3 to 14.7 m) measured at 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 between the Hyannis sea buoy ("HH") and green can "11", and pass to the north and west of Horseshoe Shoal. Vessels on the Hyannis to Nantucket route cross the North Channel, pass to the east of Horseshoe Shoal, and cross the main Channel. Ferries traveling between Martha's Vineyard and Nantucket use the Main Channel, and pass to the south of Horseshoe Shoal. (see Figure 4.3.7-1).

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 site of the proposed action. The closest port facilities that handle significant quantities of commercial products including containers and bulk cargoes are located in Providence, Rhode Island, Boston, Massachusetts and to a lesser extent New Bedford, Massachusetts. Deep draft ship traffic carrying containers and bulk cargoes do utilize Buzzards Bay for access to the Cape Cod Canal; however this vessel activity is well separated from the site of the proposed action by the Elizabeth Islands and thus would not be affected by the proposed action.

### 4.3.7.5 Recreational Fishing

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 MMFS MRFSS from three counties surrounding Nantucket Sound (Dukes, Barnstable, and Nantucket) from 1990 through-2004 were summarized (this survey is also discussed in Section 4.3.6.6). 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.

Information was summarized from the recreational fishing data including fishing effort by mode, fishing effort by hours fished as reported by individual anglers, type of gear used by individual anglers, number of fish reported by anglers, as well as the number of fish observed by interviewers during the surveys, and the fish species observed by the interviewers during surveys (Report No. 4.2.5-5).

Based on the surveyed population, the use of private or rental boats appears to be the most common mode of recreational fishing over the past 15 years. Approximately 45 percent of the anglers surveyed reported using private and/or rental boats when participating in recreational fishing activities. Those reporting the use of party or charter boats were far lower than private boats at only 15 percent. Fishing from shore was also more common than the use of charter and party boats. Approximately 40 percent of the surveyed population reported fishing from shore as the mode of fishing from 1990-2004. The average time spent fishing by surveyed anglers ranged from a low of 3.1 hours in 1993 to a high of 3.6 hours in 1997 and 2004.

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.

A complete discussion of recreational fishing and boating can be found in Section 4.3.6.6 and 4.3.6.5, respectively.

#### 4.3.7.6 Military Training

There are no designated naval training areas within the site of the proposed action and submarine activity could not occur within Horseshoe Shoal due to insufficient depths. On nearby Cape Cod, some military training activities occur at the MMR, and this may include military flights that could pass over the Horseshoe Shoal area.

#### 4.3.7.7 Outer Continental Shelf (OCS) Alternative Energy

Other reasonably foreseeable offshore alternative energy projects include 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 being considered in Vineyard Sound, approximately 10 miles (16.1 km) west of the site of the proposed action.

There is currently 804 MW of commercial offshore wind power in Europe, and a few other proposed offshore wind energy projects in the United States (Musial, 2005). 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, 2005) 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.

#### *4.3.7.8 Onshore Competing Use Activities*

The onshore portion of the proposed action includes the underground electric transmission cable system. As the cables would be entirely located under streets and underground in an existing electric transmission ROW, onshore competing uses that could affect the proposed action are limited to those specific locations. There are no known proposals for other utilities in these areas that would represent a competing use to the proposed action.

## 4.4 NAVIGATION AND TRANSPORTATION

### 4.4.1 Overland Transportation Arteries

The major overland transportation arteries in Barnstable County are U.S. Route 6, and State Routes 28 and 6A. The three towns in Barnstable County that would experience vehicular traffic related to the construction and maintenance of the wind farm include Falmouth, Barnstable and Yarmouth. The major highway in Falmouth is State Route 28, and in Barnstable and Yarmouth both Route 28 and Route 6 are major arteries. Route 28 travels in a west to east direction terminating between Chatham and Orleans. U.S. 6 continues into Cape Cod as a freeway from Bourne to Orleans. North of Orleans, Route 6 becomes a surface road again to its terminus in Provincetown.

The Regional access to the Quonset Point, which would be used for manufacturing and assembly of components, and as a marine staging/loading area, is provided by Route I-95. Route 4, a limited access highway connects Route I-95 to Route 403, which provides access directly into the area. Route 403 is a winding two-lane road which Rhode Island Department of Transportation has plans of replacing. Route 1 also passes along the entrance to the area.

#### *4.4.1.1 Roadways Located in the Vicinity of the On-land Transmission Cable*

The installation of the proposed action's onshore transmission cable system would be located under New Hampshire Avenue, Berry Avenue, Route 28 between Berry Avenue and Higgins Crowell Road, Higgins Crowell Road, Buck Island Road, Willow Street, and at the Route 6 overpass. These locations are described further below.

##### 4.4.1.1.1 New Hampshire Avenue

New Hampshire Avenue is a two-lane residential road allowing vehicle access in a north-south direction. The roadway is a dead-end roadway with a concrete retaining wall at its southern end. There are no sidewalks on either side of the roadway. In addition, there is no on-street parking. During the summer of 2002, over the course of multiple site visits, observations were made of the relative traffic volumes at various points along the proposed route. Mid-day volumes along New Hampshire Avenue were observed to be very light. The transmission cable would be installed within the east side of the roadway.

##### 4.4.1.1.2 Berry Avenue

Berry Avenue is a two-lane residential road allowing vehicle access to travel in a north-south direction. There are sidewalks on both sides of the roadway. Mid-day volumes were observed to be light. The transmission cable would cross to the west side of Berry Avenue off of New Hampshire Avenue. No on-street parking was observed on Berry Avenue. Berry Avenue is approximately 22 ft (6.7 m) wide.

##### 4.4.1.1.3 Intersection 1 - Route 28 between Berry Avenue and Higgins Crowell Road

The intersection of Route 28 with Berry Avenue and Higgins Crowell Road is a two-lane roadway with a painted divider. Vehicle access on Route 28 travels in an east-west direction. The intersection of Route 28 with Berry Avenue and Higgins Crowell Road is signalized. There are sidewalks on both sides of Route 28. Mid-day volumes were observed to be moderate to heavy. The transmission cable would be installed underneath Route 28 using trenchless technologies.

##### 4.4.1.1.4 Higgins Crowell Road

Higgins Crowell Road is a two-lane road with a painted divider. Vehicle access travels in a north-south direction. There are no sidewalks on either side of the roadway; however, there are unpaved shoulders along either side. Mid-day volumes were observed to be moderate to heavy. The transmission cable would be placed on the east side of Higgins Crowell Road. The street width for this road is approximately 24 ft (7.5 m).

##### 4.4.1.1.5 Intersection 2 - Buck Island Road

The intersection of Buck Island Road with Higgins Crowell Road is a two-lane roadway with a painted divider. Vehicle access on Buck Island Road travels in an east-west direction. The intersection of Buck Island Road with Higgins Crowell Road is signalized. Mid-day volumes were observed to be moderate to heavy. The transmission cable would be installed beneath Buck Island Road using trenchless technologies.

##### 4.4.1.1.6 Willow Street

Willow Street is a two-lane road with a painted divider. Vehicle access travels in a north-south direction. There are no sidewalks on either side of the roadway; however, there are unpaved shoulders along either side. Mid-day volumes were observed to be heavy. The transmission cable would be placed on the west side of Willow Street. The street width for this road is approximately 30 ft (9.1 m).

##### 4.4.1.1.7 Intersection 3 – Route 6 Overpass

The transmission cable would be installed using trenchless technologies as it passes underneath the Route 6 overpass. Approximately 0.5 miles (0.8 km) past the Route 6 overpass, the transmission cable would cross to the west side and enter the NSTAR Electric ROW. The transmission cable would also cross under Route 6 from the NSTAR Electric ROW from north to south to connect with the Barnstable Switching Station. This crossing would also be accomplished using trenchless techniques.

### 4.4.2 Airport Facilities

There are three airports located in the vicinity of the site of the proposed action and Nantucket Sound. These include Barnstable Airport (Boardman-Polando Field) in Hyannis on Cape Cod, and Martha's Vineyard Municipal Airport and Nantucket Memorial Airport (ACK). Provincetown Airport is also in the region. The next larger commercial airports include Logan International Airport in Boston, Massachusetts; Providence T.F. Green Airport in Providence, Rhode Island and at a greater distance yet, John F. Kennedy Airport on Long Island near New York City. The nearest military installation is Otis ANG Base in the upper western portion of Cape Cod, immediately south of the Cape Cod Canal in Barnstable County, Massachusetts. It includes parts of the towns of Bourne, Mashpee, and Sandwich and abuts the town of Falmouth.

Barnstable Municipal Airport is a vital transportation link to Cape Cod and the Islands. The airport is home to Cape Air/Nantucket Air, Island Airlines, Colgan/US Airways Express and numerous other charter, corporate and general aviation aircraft. Local airlines operate flights to Boston, Nantucket, Martha's Vineyard and New York. Aircraft operating from the airport range from J3 Piper Cubs to Cessna 402's, Falcon 50's and Boeing 727's. Barnstable's Primary Runway is has a length of 5,425 ft (1654 m) and a width of 150 ft (45.7 m). Its secondary runway has a length of 5,252 ft (1601.2 m) and a width of 150 ft (45.7 m).

Martha's Vineyard Airport is a municipal airport that serves as a vital transportation link to the mainland and to Nantucket. Cape Air regularly serves the Martha's Vineyard Airport, year-round, from many locations including: Boston's Logan Airport (BOS), New Bedford Regional Airport (EWB), Provincetown Municipal Airport (PVC), Hyannis' Boardman-Polando Field (HYA), and the ACK. U.S. Airways Express seasonally serves the Martha's Vineyard Airport from the following locations: New York's LaGuardia Airport (LGA), Washington D.C.'s Reagan National Airport (DCA), Philadelphia, Pennsylvania (PHL), and HYA. In calendar year 2004 the Martha's Vineyard Airport had 63,378 flight "operations" (an "operation" includes each landing and takeoff) and in 2005 the Airport had 60,627 flight operations. Martha's Vineyard Primary runway has a length of 5,500 ft (1,676.8 m) long and is 100 ft (30.5 m) wide. Its secondary runway has a length of 3,297 ft (1,005.2 m) long and is 75 ft (22.9 m) wide.

ACK is located in the heart of historic Nantucket Island. The airfield has three runways. The first runway is paved and is 6303 ft (1921.6 m) long and 150 ft (45.7 m) wide with pilot controlled lighting. The second runway is paved and is 3999 ft (1219.2 m) long and 100 ft (30.5 m) wide with pilot controlled lighting. The third runway is 3125 ft (952.7 m) long and 50 ft (15.2 m) wide, and also is paved. The airport can accommodate single and multi-engine aircraft, as well as corporate jets and helicopters. A control tower operates between the hours of 6:00 AM and 9:00 PM, and until 11:00 PM in the summer months. The airport has a variety of navigational aids including an instrument landing system and VOR, NDB, and GPS approaches. In 2004, airport operations totaled 144,267. Cape Air, Colgan Air, Continental, Island Airlines, Nantucket Airlines, Nantucket Shuttle, and US Airyways Express provide service to Nantucket from airports in Massachusetts, Rhode Island, and New York. Some of these airlines fly to the island seasonally.

Cape Air operates a fleet of over 50 Cessna 402's with up to 850 flights per day during high season. Colgan Air operates as Continental Connection, United Express, and US Airways Express, with 36 SAAB 340 and 11 Beech 1900D aircrafts. Island Airlines and Nantucket Airlines all operate Cessna 402's.

#### *4.4.2.1 Commercial Aviation Corridors*

High Altitude Jetways (North America – Europe and East Coast U.S.) are not considered a factor in this proposed action and are not considered in this assessment.

The proposed turbine array is not located in the flight path of any low altitude Instrument Flight Rules (IFR) routes. The IFR routes are used by aircraft flying at night or in restricted visibility, on instruments and under the control of Air Traffic Control (ATC). There are three IFR routes established for Nantucket Sound, however, they are not in the vicinity of the Horseshoe Shoal proposed action. The IFR Route

V167 that connects T.F. Green airport in Providence Rhode Island and Provincetown, Massachusetts comes from the direction of EWB and turns toward and passes north of Barnstable Airport approximately 2.3 miles (3.7 km) northwest of the proposed action at a minimum altitude of 1,600 ft (487.8 m). The IFR Route V141 from Logan Airport to Nantucket passes east of the site of the proposed action at a minimum altitude of 1,700 ft (518.3 m) and IFR Route V146 connects Martha's Vineyard with Nantucket at a minimum altitude of 2,000 ft (609.8 m) and is located approximately 9.8 miles (15.7 km) south of the proposed action. Another Route V46 that connects Nantucket with New York (Long Island) is not a factor since it lies south of Martha's Vineyard and south of V146 (Martha's Vineyard – Nantucket). IFR Route V34-58 from Block Island to Nantucket is also south of IFR V146 and north of IFR V46.

Analysis of recent aircraft flights between Rhode Island/Massachusetts and Nantucket/Martha's Vineyard revealed that most travel on the IFR routes at 3,000 to 5,000 ft (914.6 to 1,524.4 m) with some at 7,000 ft (2,134.1 m).

#### *4.4.2.2 General Aviation Traffic*

Like recreational boat traffic, general aviation (not commercial airlines or freight) is varied and increases for the summer season. Excluding high performance jet and turbo prop aircraft which generally file and follow IFR routes, general aviation use Visual Flight Rules or VFR. Low flying aircraft operating under VFR have to maintain a minimum 500 ft (152.5 m) clearance from any structure or vessel as required by 14 CFR 91.119. Over water, in the absence of any structures or vessels, there is no minimum altitude restriction.

### 4.4.3 Port Facilities

#### *4.4.3.1 General Description of the Area*

As shown in Figure 4.3.7-1, Nantucket Sound is bounded to the south by the islands of Martha's Vineyard and Nantucket, and to the north by Cape Cod. To the west of Nantucket Sound is Vineyard Sound, and to the east is the Atlantic Ocean. Horseshoe Shoal is located in the approximate middle of Nantucket Sound, with its geometric center at approximately 41°30'N; 70°20'W. The northeasterly tip of the shoal is known as "Broken Ground." The southeasterly tip of the shoal is known as "Halfmoon Shoal."

Nantucket Sound is used for navigation by recreational watercraft, commercial fishing vessels and commercial vessels engaged in waterborne commerce. Peak usage by recreational watercraft and commercial fishing vessels is during the warmer months of the year (typically April through October). Pilotage is not typically required for vessels transiting through central and eastern Nantucket Sound.

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

- The Main Channel in Nantucket Sound is located south of Horseshoe Shoal. This channel is used by most of the vessels transiting through Nantucket Sound. It is reported that vessels using the channel seldom exceed a draft of 24 ft (7.3 m) (NOAA, 2008).
- The North Channel runs along the north side of Nantucket Sound, on either side of Bishop and Clerks, northward of Horseshoe Shoal, between Wreck Shoal and Eldridge Shoal, northward of L'Hommedieu Shoal, and through one of the openings in the shoals westward of L'Hommedieu Shoal into Vineyard Sound. 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 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 4.3.7-1).

The area between the Main Channel and the Cape Cod shoreline, including Horseshoe Shoal, is designated as an anchorage named “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).

The Coast Pilot describes Nantucket Sound as being located between the south coast of Cape Cod on the north, Nantucket Island and part of Martha’s Vineyard on the south, and Vineyard Sound on the west. Nantucket Sound has a length of about 23 miles (37 km) in an east-west direction and a width of 6 to 22 miles (9.7 to 35.4 km) in a north to south direction. At the eastern entrance and within the Sound are numerous shoals. Between the shoals are well-marked channels making the navigation of these waters comparatively easy for powered vessels and also sailing vessels with a fair wind. The shoals at the eastern entrance are subject to considerable shifting while those inside the Sound are somewhat more stable. Boulders are located along the shores in some locations.

Numerous fish traps are located in Nantucket Sound, particularly along the southern shore of Cape Cod. The Sound is home to many shoals and mariners need to stay vigilant to safely navigate these waters with their swift currents, convection fog in summer months, high winds and relative choppy seas in winter storms, and during adverse weather fronts moving through the area throughout the year.

The USCG has categorized the waters of Nantucket Sound as both Navigationally Critical and Environmentally Critical through its Waterways Analysis and Management System (WAMS). This means that for the waterway, degradation of the aids to navigation system would result in an unacceptable level of risk of a marine accident affecting the national economy due to the physical characteristics of the waterway, difficult navigational conditions, aid establishment difficulties, or high aid discrepancy rates. Environmentally Critical Waterways are waterways where a degradation of the aids to navigation system would present either an unacceptable level of risk to the general public or to sensitive environmental areas, because of the transport of hazardous material or dangerous cargoes. Information from the USCG’s 2004 Waterways Analysis and Management System (WAMS) report notes in its characterization of the waters of Nantucket Sound – Anchorage I (which includes Horseshoe Shoal) that “there is little or no reported commercial use of the anchorages due to the dangerous shoal water in the vicinity coupled with adequate harbors of refuge capable of accommodating most waterway users” and that “it is apparent these anchorages are disproportionate to the waterway and pose a myriad of safety issues as they relate to providing a safe, navigable waterway for the user.” As a result, the WAMS report recommends that the USCG reevaluate the necessity and size of these anchorages.

#### *4.4.3.2 Ports and Marinas*

There are no major or significant Port Facilities that handle large deep draft traffic and are engaged in commercial cargo trade in the vicinity of the site of the proposed action. The closest Port Facilities that handle significant quantities of commercial products including containers and bulk cargoes are located in Providence, Rhode Island, Boston, Massachusetts and to a lesser extent New Bedford, Massachusetts. Deep draft ship traffic carrying containers and bulk cargoes do utilize Buzzards Bay for access to the Cape Cod Canal; however this vessel activity is well separated from the site of the proposed action by the Elizabeth Islands and thus would not be affected by the proposed action.

There are many small ports surrounding Nantucket Sound that are home to a plethora of both sail and motor, small and large recreational vessels, excursion/sight seeing vessels and private and commercial fishing vessels and passenger vessels. There are larger ports that are the ports of embarkation for the extensive Passenger/Vehicle/Cargo ferry system that connects Cape Cod and the mainland with the Islands of Nantucket and Martha's Vineyard. This ferry system operated by the Martha's Vineyard and Nantucket Steam Ship Authority (SSA) is a vital link between the Islands and the Mainland. The ferry system provides goods and services to both residents and industry on Martha's Vineyard and Nantucket Islands. The SSA operates from Hyannis, Massachusetts with ferries to Nantucket and from Woods Hole, Massachusetts with ferry service to Martha's Vineyard calling on their main year-round port at Vineyard Haven and their seasonal port of Oak Bluffs from May to October. The port of Oak Bluffs and Vineyard Haven are approximately 3.5 miles (5.6 km) apart. The SSA operates their Hyannis to Nantucket service year round with the addition of a seasonal high speed ferry service that starts in April and takes approximately one hour to make the transit from Hyannis to Nantucket Island. These ferries carry passengers, personal vehicles and large tractor trailers loaded with goods for the economy of both islands. Other than transportation by air, the ferry service is by far the major means delivering essential goods to the islands and their economies.

There are other passenger ferries operating from Cape Cod (Falmouth) and Rhode Island taking passengers to Martha's Vineyard and Nantucket. Departing from New York, Clipper Cruise Lines operates a small passenger vessel that calls at Oak Bluffs or Vineyard Haven, on Martha's Vineyard and Nantucket Island during the summer months. Other than the SSA, none of these vessels require extensive port facilities other than a dock to off-load and on-load passengers for a day excursion ashore. The SSA operates at port facilities that employ roll-on and roll-off capabilities and sufficient land area to stage waiting vehicular and tractor trailer cargo. None of the ports found surrounding Nantucket Sound have sophisticated and extensive cargo handling capabilities.

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) from other parts of New England and beyond. 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.

#### *4.4.3.3 Commercial Ship Traffic and Berthing*

Commercial ship traffic for the purposes of this report is defined as that traffic that either takes on passengers for hire or is involved in commercial trade which may involve the carriage of cargo, packaged, containerized or bulk. This would include the Passenger/Cargo/Vehicular Ferry Systems that operate from different ports in Massachusetts including Cape Cod as well as from Rhode Island; commercial fishing vessels (fish, shell fish and lobster for sale and not personal consumption) and other vessels that deliver goods and services to the islands and transit Nantucket Sound. Some of the commercial vessel traffic operates on a year round basis (SSA and commercial fishing fleet) and on a schedule while other commercial traffic operates on a seasonal basis (ferries from Rhode Island and fast ferry from Hyannis).

The USCG Waterway Analysis and Management System of 2004 provides the following as commercial users of Nantucket Sound:

- Nantucket and Martha's Vineyard Steamship Authority operating out of Woods Hole and Hyannis, Massachusetts; Falmouth Ferries; Hy-Line Cruises; Patriot Party Boats; Freedom Cruise Lines; Hyannis Cruise Lines; Tisbury Towing (New Bedford, Massachusetts) and Shearwater Excursions.
- The Woods Hole Oceanographic Institute and NOAA operate several large oceanographic vessels that are home ported at Woods Hole and deploy throughout the world.
- Commercial Fishing vessels located throughout the many harbors surrounding Nantucket Sound with the highest concentration being in New Bedford, Massachusetts that transit through Nantucket Sound enroute to fishing grounds in the area and Georges Bank. An estimated two hundred to two hundred and fifty commercial fishing vessels transit this area to and from fishing grounds. It is also estimated that approximately 50 to 80 commercial fishing vessels fish in the Nantucket Sound itself.
- Large USCG Aids to Navigation cutters are stationed in Woods Hole, Massachusetts and smaller rescue boats at USCG Stations located at Menemsha, Martha's Vineyard, Brandt Point, Nantucket and Chatham, Massachusetts. These Stations are assigned the primary duties of patrolling and conducting search and rescue operations within Nantucket Sound and elsewhere.
- Clipper Cruises operating out of New York City also has a seasonal passenger vessel service that calls on ports in Martha's Vineyard and Nantucket.

From the Waterways Analysis the major ports that support commercial vessel operations surrounding Nantucket Sound include:

- Woods Hole, Falmouth and Hyannis in Barnstable County, Massachusetts
- Vineyard Haven and Oak Bluffs, in Dukes County, Massachusetts
- Nantucket Harbor in Nantucket County, Massachusetts

To support operation of these vessels, the ports have deep water piers and quays to allow these vessels to come along side and discharge their cargo and passengers. The SSA has a significant staging area to stack vehicular traffic awaiting arrival and the loading of ferries at both Woods Hole and Hyannis and at their ports of call in Martha's Vineyard and Nantucket.

The largest commercial vessels known to routinely operate in Nantucket Sound are in the order of 230 to 280 ft (70.1 to 85.4 m) in length; 13 to 20 ft (4 to 6.1 m) in draft and are approximately 1800 gross tons. These ships are of the type operated by the SSA and other operators engaged in commerce with the Islands. The height overall for these vessels is approximately 70 ft (21.3 m). Other vessels, cruise ships, of up to 330 ft (100.6 m) (*Clipper Adventurer*) and 4,300 gross tons have called on ports in the area of study.

#### 4.4.3.4 Ship, Container and Bulk Oil Handling Facilities

There are no ship and container handling facilities in ports surrounding Nantucket Sound. Containers are carried on SSA ferries as part of a tractor trailer rig and are on and off loaded by driving the rig onto or off the vessel on its vehicle deck. There are bulk liquid facilities at Vineyard Haven and Nantucket for offloading petroleum products that are transported by the *T/V Great Gull* and other barges. The largest ship handling facilities are those owned and operated by the SSA and the oil transfer facilities in Vineyard Haven and Nantucket.

### 4.4.3.5 Navigation Channels

Due to the characteristics of the waterway, most commercial traffic is restricted to navigation by its draft and for safety reasons to the navigation channels marked by the USCG. The area is transected by two named channels but only one major channel that provides a route for medium sized vessels to transit in an east/west direction in an area north of the Nantucket Shoals. Called the Main Channel, this passage way 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 to the north, and Hawes Shoal (Chappaquiddick Island) to the south. The channel is fairly wide in most areas being approximately 1.15 miles (1.9 km) across from edge to edge as marked on NOAA Chart 13237 for a draft of 30 ft (9.1 m). It constricts down to approximately 0.86 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 and splits at the channel heading toward Nantucket Island. The channel width heading toward Nantucket Harbor is approximately 1 mile (1.6 km) and narrows to approximately 300 ft (91.4 m) in width upon entering Nantucket Harbor. The Main Channel continues and turns east north east and then north east 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 through this area is narrow.

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 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).

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 1 to 45 ft (13.7 m) measured at MLLW. The majority of the Shoal is 20 to 30 ft (6.1 to 9.1 m) at MLLW (see Figure 4.4.3-1). Approximately 91 percent of Horseshoe Shoal has charted depths of 30 ft (9.1 m) or less MLLW. This fact limits the vessels that can transit over the shoals at any given time. 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. A further breakdown of vessel type, size, draft, and ability to navigate the depth limitations at Horseshoe Shoal is provided in the *Revised Navigational Risk Assessment* (Report No. 4.4.3-1). Due to the swift currents and rapidly changing depths of water over very short distances steep short period waves are created that break on the shoal making operations more difficult.

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 would follow the Main Channel until the Nantucket Channel intersects in the vicinity of Half Moon Shoal (see Figure 4.3.7-1).

The width of the Main Channel varies from approximately 1.15 nautical miles (1.6 km) at the eastern entrance to the channel, to approximately 0.86 nautical miles (1.4 km) at Cross Rip Shoal. The constriction for the North Channel in the vicinity of the proposed action at the Red #8 and Green Can 11 is 0.8 miles distant. The typical spacing between WGT's in the proposed action is 0.62 miles (1 km) by 0.39 miles (0.6 km).

### 4.4.3.6 Cruise Ship Traffic

For purposes of this assessment, Cruise Ships are defined as vessels that take passengers for hire and provide an itinerary that requires over night accommodations and visits to a number of ports on a multi day cruise. Cruise Ships call on Ports in Martha's Vineyard and at Nantucket. Clipper Cruise Lines operating out of New York City have in the past and plan to continue to call on Martha's Vineyard and Nantucket. Their vessels the *Clipper Adventurer* and the *Yorktown Clipper* have called on the area in the past. The *Clipper Adventurer* is 330 ft (100.6 m) long with a beam of 53.5 ft (16.3 m) and a draft of 15.5 ft (4.7 m). The *Yorktown Clipper* is 257 ft (78.4 m) in length, has a 43 ft (13.1m) beam and has a draft of 8 ft (2.4 m). The *Nantucket Clipper* continues to be listed as a possible visitor to the area. American Cruise Lines offers a New England Island itinerary that sails out of Providence, Rhode Island and visits both Martha's Vineyard and Nantucket in two vessels, the *American Spirit* (which is about 214 ft [65.2 m] long and carries 93 passengers) and the *American Glory.* Both vessels operate on a similar itinerary from June through the end of September. Their voyage plan calls for them to enter Nantucket Sound from Vineyard Sound at Nobska Point and use the Main Channel for transit to a port call in Nantucket and then return to Martha's Vineyard for the second port call exiting the Sound through Vineyard Sound enroute to Fall River, Massachusetts.

Due to the nature of the waterway, the harbor pilots state that they do not take vessels with drafts in excess of 24 ft (7.3 m) or greater east of a point located at 41-46.0N 70-54.3W just northeast of East Chop on Martha's Vineyard. Passenger vessels and cruise ships bound for a port call on Martha's Vineyard at Oak Bluffs or Vineyard Haven always approach these areas from the west (Vineyard Sound) and depart to the west at the termination of the port call. This track puts these vessels approximately 8 miles (13 km) NW from the nearest proposed WTG on Horseshoe Shoal.

### 4.4.3.7 Overwater Passenger Ferry Traffic

Passenger and freight ferries (including high-speed ferries) bound for both Nantucket and Martha's Vineyard operate out of Hyannis Inner Harbor and transit the area near Horseshoe Shoal. Steamship Authority vessels do not transit over Horseshoe Shoal. Ferries bound for Nantucket transit to the east of Horseshoe Shoal, while ferries bound for Martha's Vineyard transit to the north and west of the shoal (see Figure 4.3.7-1). According to USACE data for the 1998 through 2000 timeframe, an annual average of 1,305 vessel trips for vessels engaged in waterborne commerce were reported as passing Cross Rip Shoal, which is to the south of Horseshoe Shoal and the Main Channel.

The over water passenger ferry services in Nantucket Sound are the largest and most frequent users of the waterway; they carry thousands of passengers to and from the islands as well as most of the freight necessary to support the islands population and industry. The SSA operates a fleet of nine passenger/vehicle and freight/passenger ferries that service the islands from Hyannis and Woods Hole. The SSA operates 56 transits (28 round trips) per day starting at 0600 to 2330 over the summer months between Woods Hole and Martha's Vineyard by two vessels (Each vessel has seven round trips or fourteen transits per day). The run takes approximately 45 minutes from dock to dock. The traditional passenger/vehicle service from Hyannis to Nantucket takes 2 hours and 15 minutes and there are 12 transits (by two vessels [Each vessel makes three round trips or six transits per day]). In the summer months, the fast ferry *Flying Cloud* also makes 10 transits or 5 round trips per day from Hyannis to Nantucket in one hour. While the normal ferries operate at 14 to 15 knots (7.2 to 7.7 m/s), the *Flying Cloud* operates at 34 knots (17.5 m/second) or about 40 miles (74.1 km) per hour to make the one hour transit between Hyannis and Nantucket. The SSA ferries have drafts ranging from 7 ft to 12 ft (2.1 to 3.7 m).

Falmouth Cruises operates a passenger ferry regularly from Falmouth Harbor to Oak Bluffs. Eighteen transits are made daily in the summer season.

Hy-Line operates year round high speed ferries from Hyannis to Nantucket and Martha's Vineyard as well as traditional passenger ferry services (seasonal) to both islands and inter-island. The high speed passenger-only ferries operate ten transits per day to Nantucket and ten transits per day to Martha's Vineyard. Hy-Line's tradition ferry that operates seasonally makes six transits to Oak Bluffs, Martha's Vineyard. The Nantucket Ferry operates at six transits per day during the summer season as well as a high speed ferry that operates between Martha's Vineyard and Nantucket two transits per day in the summer months.

Freedom Cruise Lines operate a traditional passenger only ferry from Harwich Port to Nantucket. Its schedule shows six transits per day during the peak summer season.

Most of the commercial vessels routinely using the Nantucket Sound area conservatively have drafts less than 20 ft (6.1 m), 46.3 percent of the proposed action (96 WTGs) is located in waters with depths greater than 20 ft (6.1 m). Thirty-four of the 130 planned WTGs are located within this area. Refer to Table 4.1 of Report No. 4.4.3-1.

### *4.4.3.8 Marinas and Recreational Boating*

There are over forty marinas located in the immediate area surrounding Nantucket Sound. Most are located on Cape Cod. There are marinas and mooring areas located on both Martha's Vineyard and Nantucket predominately on Martha's Vineyard in Vineyard Haven, Menemsha, Oak Bluffs, and Edgartown. On Nantucket most marinas and moorings are located in the main harbor. Recreational traffic in the Sound is seasonal with the summer months from June to October seeing a dramatic increase on water activities by recreational traffic both by boats that originate from the area marinas as well as recreational craft that visit the area from the entire New England and Mid Atlantic Region.

Nantucket Sound is a well known area that attracts all types of recreational craft from the smallest runabout to very large and expensive yachts. These yachts not only include world class power boats/cruisers privately or corporately owned (*Lone Ranger 254 ft/Acquisition 121 ft*) but also sail boats of all sizes (*Southern Cross Maxi 88*). Many remain in the region for the entire boating season, while others use the area to transit to other ports of call along the New England and Mid Atlantic Coasts as well as Canada.

**Recreational Marine Events**

The website at USCG Sector Woods Hole provides a partial list of marine events in its area of operations that include Nantucket Sound. This site lists contains several events in the Nantucket Sound area, however they are located near shore and in various harbors of the Cape and the Islands.

One event called the Figawi Race between Hyannis and Nantucket and back is held every year on Memorial Day. It involves sailboats with LOA's of 20 ft (6.1 m) or greater. The actual course varies from year to year but typically starts to the north of and proceeds around or over portions of Horseshoe Shoal. Figure 4.4.3-2 shows the six courses published in the 2003 Figawi Race Sailing Instructions and similar to those published in the 2005 Figawi Race Sailing Instructions.

### *4.4.3.9 Commercial Fishing*

As is the case for recreational traffic, sources of fishing vessel traffic using Nantucket Sound is too broad to list due to the independence and mobility of fishing activity and practices. Various sources documented that over 70 fishing vessels varying from 30 to 60 ft (9.1 to 18.3 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, Massachusetts 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 ft (18.3 to 30.5 m) in length and have drafts of 8 to 15 ft (2.4 to 4.6 m).

Many newer and more profitable fishing vessels are well maintained and equipped with an extensive array of navigation and fish finding technology to support extended offshore operations and are staffed by seasoned and professional masters as well as adequate crew. Other fishing vessels are marginally seaworthy and minimally manned with only the most basic of navigation equipment. During bad weather or when making repairs, these vessels have been known to use the General Anchorages in the vicinity of the site of the proposed action.

### 4.4.4 Communications: Radar, Television, Radio, Cellular, and Satellite Signals and Beacons

#### *4.4.4.1 Existing Conditions*

The proposed action area encompasses a substantial amount of water within which a number of communications services are in use. These services fall into the following primary categories:

1. Recreational Communications (satellite, radio, TV, non-emergency cellular)
2. Navigation and Positioning Services
3. Safety and Emergency Communications
4. Aviation and Military Surveillance Radar

##### 4.4.4.1.1 Communications Towers in Area

To evaluate potential impact to existing RF communications in the area, a search of the FCC antenna structure database was made to identify existing and proposed communications towers in the area around Nantucket Sound, including Cape Cod and the islands. A search radius of 25 miles (40 km) from the center of the turbine area was used. This search revealed 69 existing structures that have been notified to the FCC; 51 of these are on the mainland, 11 are on Martha's Vineyard, and 7 are on Nantucket. There are 12 other tower notifications that are in "granted" status, meaning that they have been approved but the FCC has not been notified of their construction. Nine of these are on the mainland, one is one Martha's Vineyard and two are on Nantucket.

The antenna structures found in the area are a mix of broadcast towers, cellular base station towers, local public safety communications towers, and towers for industrial and business use.

##### 4.4.4.1.2 Broadcast Service in Area

On the AM broadcast band, there is one fulltime local station serving the Cape Cod area, WBUR on 1240 KHz, in West Yarmouth. There are also AM signals that are received from more distant stations.

There are 20 licensed full-service FM broadcast stations whose transmitters are within 25 miles (40 km) of the center of the turbine area. Seven of these are on the non-commercial band (88 to 92 MHz).

Many of these stations are low-power (less than 6 kWs) and may not cover the entire Cape Cod area. More distant FM signals are available from New Bedford, Plymouth and other communities.

On the TV broadcast band, local signals include WMPX-LP, a low-power station on Channel 33 in Dennis, and full-power station WDPX at Vineyard Haven (analog Channel 58, HDTV Channel 40). Barnstable, Dukes and Nantucket Counties are in the Boston Designated Television Market Area, but are also served by TV stations in Providence, Rhode Island.

#### 4.4.4.1.3 Aviation and Military Radar Facilities

The closest public airport with a control tower is Barnstable Municipal/Boardman Polando Field in Hyannis. The control tower is more than 8 miles (12.9 km) from the nearest turbine site.

There are two Terminal Radar Approach Control (TRACON) stations within 57.5 miles (92.6 km) of the turbine area. TRACONs are FAA radar stations staffed by air traffic controllers that guide aircraft approaching and departing airports generally within a 34.5 to 57.5 miles (55.6 to 92.6 km) radius up to 10,000 ft (3048 m), as well as assure safe separation of aircraft flying in busy areas near airports. The two TRACONs are at Otis Air Force Base on Cape Cod, about 10 miles (16.1 km) from the nearest turbine, and Theodore Francis Green State Airport in Providence, about 54 miles (87 km) from the nearest turbine.

The nearest Air Route Traffic Control Center (ARTCC) is in Nashua, New Hampshire, about 99 miles (159 km) from the nearest turbine. The purpose of an ARTCC is to guide aircraft at altitudes above 10,000 ft (3038 m) while in mid-flight.

There is a Long Range Joint Use[19] Radar Station (ARSR) in the area, located near North Truro, Massachusetts. The station is about 36 miles (57.9) from the nearest turbine site.

The PAVE PAWS radar station in the north portion of the Massachusetts Military Reservation, near Sagamore, is about 17 miles from the nearest planned turbine. PAVE PAWS is an Air Force Space Command radar system providing detection of ballistic missiles and space surveillance.

The closest VOR navigation beacon is located at Otis Air National Guard Base and is owned by the Department of Defense. There is no mechanism in place for the Department of Defense to share their plans with the FAA to phase out NAVAIDS in favor of GPS systems. However, it appears logical that t the more accurate GPS system would eventually replace the less accurate and fuel-wasting VOR system.

During the FAA aeronautical study, all instrument approach procedures and navigational aids were considered, including VOR impact, and it was determined that the turbine proposal did not affect any instrument approach procedure or navigational aid. The study also considered any GPS procedure that was on file.

The Cape Wind turbine proposal is unique, and proposes to use modern Glass Reinforced Plastic composite blades that have the minimum effect upon radar and communications facilities. Comparisons between impact results obtained at other turbine sites, whether domestic or international, should be conducted with caution.

[19] "Joint Use" means that the radar station is shared by the FAA and the U.S. Military.

Interference results obtained from one turbine site study, especially one that has been conducted many years ago, do not map directly onto a proposed new project because the following factors are not the same:

- Blade composition
- Blade profile
- Blade length
- Configuration of lightening protection wire
- Configuration of mechanical blade supports
- Dimensions of turbine support structures
- Type of equipment used for measurements
- Methodology and test equipment used for measurement procedure

The interference impact is highly dependent and variable depending upon the above factors, to the point where any differences completely negate the predictive value of the measurements. These and other potential communications interference topics are discussed in Section 5.3.4.

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