Appendix H

Essential Fish Habitat (EFH) Assessment

Cape Wind Energy Project

Final EFH Assessment

Minerals Management Service
for Consultation with the
NOAA Fisheries

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1.0 INTRODUCTION

Many marine habitats are critical to the productivity and sustainability of marine fisheries. The 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) require that an Essential Fish Habitat (EFH) consultation be conducted for any activity that may adversely affect important habitats of federally managed marine and anadromous fish species. EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (16 U.S.C. 1802(10)). "Waters" in the above definition refer to the physical, chemical and biological properties of aquatic areas that are currently being used or have historically been used by fish. "Substrate" refers to sediment, hard bottom, or other underwater structures and their biological communities. The term "necessary" indicates that the habitat is required to sustain the fishery and support the fish species' contribution to a healthy ecosystem. The term "adverse effect" means any impacts which reduce quality and/or quantity of EFH. Adverse affects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species, and their habitat, and other ecosystem components. Adverse effects may be site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.910).

The Minerals Management Service (MMS), through its authority to lease land on the Outer Continental Shelf (OCS) for renewable energy projects, oil and gas wells, sand mining, and certain other activities, has responsibility as the lead federal agency to initiate an EFH consultation prior to approving the proposed action. This document has been prepared as an appendix to the Final Environmental Impact Statement for the purposes of complying with the Magnuson-Stevens Act in regards to EFH consultation. MMS is requesting that NOAA Fisheries use this document, in conjunction with the remainder of the Final Environmental Impact Statement (Final EIS), in evaluating the proposed action relative to EFH and EFH species.

2.0 DESCRIPTION OF PROPOSED ACTION

2.1 Facilities Description

The proposed offshore wind energy facility consists of the installation and operation of 130 Wind Turbine Generators (WTGs) on Horseshoe Shoal (the site of the proposed action) in Nantucket Sound, along with an Electric Service Platform, inner array electric cables, and two transmission cables onto shore. The WTGs would produce an average of 182.6 megawatts (MW) (up to a maximum output of 468 MW) of electricity using the wind resources off the coast of Massachusetts. Wind-generated energy produced by the WTGs would be transmitted via a 33 kV submarine cable system (inner array cables) to the Electric Service Platform (ESP) centrally located within the WTG array. The ESP would then take the wind-generated energy from each of the WTGs and transform and transmit this electric power to the mainland electric transmission system via two 115 kV alternating current (AC) offshore transmission cable circuits (offshore transmission cable system) to the selected landfall site at New Hampshire Avenue in Yarmouth, Massachusetts. The offshore transmission cable system would then interconnect via horizontal directional drilling (HDD) with the onshore transmission cable system. The onshore transmission cable system would be installed underground within existing rights of way (ROWs) and roadways in the Town of Yarmouth and Barnstable, where it would interconnect with an existing NSTAR Electric Barnstable Switching Station. The energy produced would be transmitted by the transmission cable system to the electric transmission system serving Cape Cod, the Islands of Nantucket and Martha's Vineyard ("the Islands"), and the New England region.

2.2 Summary of Construction Methodology

Construction would involve the installation of 130 WTGs in Nantucket Sound, an ESP within the WTG array, inner array cables to connect each WTG to the ESP, and two offshore transmission cable circuits to connect the ESP to the landfall area in Yarmouth, Massachusetts. One monopile foundation would be constructed to support each of the 130 WTGs and six smaller monopile foundations would support the ESP. The monopiles would be installed using vibratory pile driving technology and would be driven approximately 85 feet (ft) (26 meters [m]) into the seabed. To prevent scour around the monopiles, seabed scour control systems (SSCS) would be installed. These systems consist of a combination scour mats and rock armor. The scour mats are seagrass-like buoyant polypropylene “fronds” and polyester webbing which is anchored securely to the seabed and would serve to reduce the velocity of water circulation around the foundations, thereby preventing scour at the base of the monopiles. The current scour protection scenario calls for scour mats to be used on 106 WTGs and the ESP and the rock armor to be used on the remaining 24 WTGs. The applicant is requesting that the use of rock armor be allowed in any areas that scour mats are found to be less effective, with the extreme case being rock armor scour control used at all of the WTGs and the ESP. See Section 2.3.2 of this final EIS for more a detailed discussion on scour control. Spud barges and jack-up barges would be used to facilitate the installation of the WTG monopiles which can range in diameter from 16.75 ft to 18 ft (5.1 to 5.5 m) and the ESP.

The two offshore transmission cable circuits connecting the ESP to the landfall location and the inner array cables connecting each WTG to the ESP would be installed in the seabed using hydraulic jet-plow embedment technology. This method utilizes pressurized water jets to create a localized path along the seafloor into which the cables are immediately positioned and start to sink into the fluidized sediments. The sediment displaced by the jet-plow then begins to settle over the created path, thereby burying and protecting the cable. The localized pathway disturbed to install each circuit would be approximately 4 to 6 ft (1.6 to 1.8 m) wide and 8 ft (2.4 m) deep to reach an approximate 6 ft (1.8 m) burial depth. Because the inner-array cables would be buried to depths of 6 ft (1.8 m) below sea bottom, the potential for conflicts with anchoring or fishing activities would be minimized. Scour is not anticipated to affect the sediment cover over the buried inner-array cables, as the scour is caused by the interaction of waves and currents around a structural object at the sediment surface. Nonetheless, the inner-array cables would be inspected periodically to ensure adequate coverage is maintained. If problem areas are discovered, the submarine cables will be reburied.

Anchoring would be required for cable installation barge positioning. Typically a 6 or 8-point mooring system is employed, with anchors deployed up to several thousand feet from the installation barge. Depending upon water depths and anchor cable tensions, a portion of the anchor cable lengths would contact the seafloor.

The transition of the offshore transmission cable system from water to land would be accomplished through the use of HDD methodology in order to minimize disturbance within the intertidal zone and near shore area. The HDD would be staged at the upland landfall area and involve the drilling of the boreholes from land toward the offshore exit point. Conduits would then be installed the length of the boreholes and the transmission line would be pulled through the conduits from the seaward end toward the land.

The offshore end of the conduits would terminate in a pre-excavated pit where the jet plow cable burial machine would start. To further facilitate the HDD operation, a temporary cofferdam would be constructed using steel sheet piles at the end of the boreholes. Approximately 840 cubic yards (yd^3) (642.2 cubic [m^3]) of sediment would be excavated from the area inside the cofferdam to expose the seaward end of the borehole. The dredged sediments from within the cofferdam pit would be temporarily removed and replaced upon completion of the transmission cable system installation. The top of the sheet piles would be cut-off approximately 2 ft (0.6 m) above mean high water (MHW) to contain any turbidity associated with the dredging. The area enclosed by the cofferdam would be approximately 2,925 square feet (ft^2) (272 square meters [m^2]), a minimal area compared to surrounding habitat in Lewis Bay. See Section 2.3 of this final EIS for more detailed information on HDD construction and installation methodologies.

Information on general types and estimated numbers of vessels expected to be involved during various phases of construction is included in Section 2.3 of this final EIS. During pile driving activities, it is estimated that approximately 4-6 vessels would be present in the general vicinity of the pile installation. Most of these vessels would be stationary or slow moving barges and tugs conducting or supporting the installation. Other vessels would be delivering construction materials or crew to the site and would be transiting from the various points on the mainland to the construction site and back. Barges, tugs and vessels delivering construction materials would travel at 10 knots (5.1 m/s) or below and may range in size from 90 to 400 ft (27.4 to 122 m). The only vessels that are anticipated to be traveling at greater speeds are crew boats that would deliver and return crew to the construction site twice per day. Crew boats are anticipated to be approximately 50 ft (15.2 m) in length and may travel at speeds up to 21 knots (10.8 m/s). These crew boats are similar to typical vessel traffic occurring in Nantucket Sound already on a regular basis.

2.3 Summary of Operation/Maintenance Methods

Wind-generated energy produced by the WTGs would be transmitted via the inner-array cables to the ESP centrally located within the WTG array. The ESP would then take the wind-generated energy from each of the WTGs and transform and transmit this electric power to the mainland electric transmission system via two 115 kV AC transmission cable circuits.

Maintenance required for the 130 WTGs would be distributed among two to three crews, thus likely resulting in daily trips to the offshore site estimated to be at least 250 days per year. In the event that a WTG or a section of the inner-array or transmission cable systems require repair during operation, methodologies for conducting this repair are expected to be similar to those used during construction; however, impacts would be limited to the immediate vicinity of the WTG or portion of the cable system requiring repair. The maintenance program would include preventive and emergency maintenance functions including shore based predictive maintenance analysis of the WTG and ESP. These visits cover two days of planned or preventative maintenance, and three days of unplanned or forced outage emergency maintenance. See Section 2.4 of this final EIS for a more detailed description of operation and maintenance procedures.

2.4 Summary of Decommissioning Methods

Decommissioning involves dismantling the WTGs and ESP, removing scour control mats or armoring, removing the inner-array cables and transmission cable system, and transporting all parts to shore for recycling. In deconstructing the WTGs down to the transition piece, the blades, hub, nacelle and tower would come apart in the same manner that they were put together utilizing similar equipment. The monopile, with the transition piece, would be cut off at the mud line followed by the removal of the sediment within it to a suitable depth (approximately 15 ft (4.6 m) below the level of the seabed). Once the sediments have been removed, the remaining monopile would be cut off at a depth of approximately 15 ft (4.6 m) below the surface. The monopile would be placed on a barge and brought to shore for recycling. The excavated sediments would be replaced in the excavation remaining after the monopiles are removed.

Decommissioning for the ESP would be a reverse process of the construction activities and would commence when the 33 kV and 115 kV cables have been disconnected and removed from the ESP. The heliport, ladders and boat platform would be removed by cutting and placed on a barge. The superstructure would than be lifted onto a vessel and moved to port. The balance of the jacket structure would be cut from the piles and lifted out of the water for placement on barges. The piles would be cut below the mud line and removed. Any scour protection would also be removed and taken to shore for disposal.

During decommissioning, the submarine cables would be disconnected and pulled out of the J-tubes on both the WTG and the ESP, and the cables would be cut below the seafloor. The cables would then be reeled in after being water jetted free of the bottom sand. The reels would be transported to the staging area for further handling. It is expected that all metal from the cable would be reused via recycling. The equipment used to remove the submarine cables would be similar to that used for installation (barge, attendant tugs and jet plow equipment). The objective of the decommissioning process would be to return the proposed action area to its pre-existing state (see Section 2.5 of this final EIS for a complete discussion of the decommissioning process).

3.0 AFFECTED ENVIRONMENT

This section describes the physical and biological characteristics in Nantucket Sound in general, within the WTG array site, and along the electric transmission cable route. Some additional information expanding upon the information presented in this section is found in body of this final EIS within Section 4.0.

3.1 Physical Environment

The characterization of the physical environment of Nantucket Sound has been presented in subsections on hydrography, currents, salinity, temperature, sediment distribution, sediment quality, and sediment transport. Information is drawn from published literature and from studies conducted by the applicant. The following description of the physical environment of Nantucket Sound provides a basis for understanding the oceanographic processes that affect potential EFH and federally managed species in this area.

Hydrography

In general, the bathymetry in Nantucket Sound is irregular, with a large number of shoals present in various locations throughout the glacially formed basin. Charted water depths in the Sound range between one and 70 ft (0.3 and 21.3 m) at mean lower low water (MLLW). 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 are as shallow as 0.5 ft (0.15 m) at MLLW. 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 is present 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 route, 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 eight to 14 ft (2.4 to 4.3 m) at MLLW in the center of the bay to less than five ft (1.5 m) at MLLW along the perimeter and between Dunbar Point and Great Island.

Tidal Flow and Circulation

The water currents in Nantucket Sound are driven by strong, reversing, semidiurnal tidal flows. Wind-driven currents are only moderate because of the sheltering effect of Nantucket and Martha's Vineyard. The tidal range and diurnal timing are variable because of the semi-enclosed nature of the Sound and the regional variations in bathymetry. Typical tidal heights are in the range of one to four ft (0.3 to 1.2 m) with tidal surges of up to approximately ten ft (3.0 m) having been recorded during hurricanes (Bumpus et al., 1973; Gordon and Spaulding, 1979). Times of high and low tides vary in different parts of the Sound by up to two hours.

Tidal flow and circulation within the Sound generate complex currents, the direction of which forms 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). The tidal current flows to the east during the flood tide (incoming) and to the west during the ebb tide (outgoing). Peak tidal currents often exceed two knots (1 m/s) (Bumpus et al., 1973). 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 ft^2 (200 m^2) per tidal cycle, roughly 5 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 with the results as follows. Flood currents on the shoals in Nantucket Sound are generally directed easterly and ebb currents are generally directed westerly. Local changes in tidal current direction occur on the shoals due to the nearby shoreline shape and bathymetric features. Currents at Horseshoe Shoal are diverted slightly around the shallowest portion of the shoal. Flood currents also are generally stronger than ebb currents and spring tidal currents are approximately 15-20 percent stronger than mean tidal currents. Tidal current velocities were calculated to be approximately 2 feet per second (ft/s) (0.6 meters per second [m/s]) at Horseshoe Shoal. Wind-driven current velocities modeled at Horseshoe Shoal were found to be much lower than tidal velocities and concentrated over the crest of the shoal (Report No. 4.1.1-9).

Site specific current data was collected using an Acoustic Doppler Current Profiler (ADCP) at the Scientific Measurement Devices Station (SMDS) between April 2003 and September 2004. The ADCP was configured to collect 280 seconds of current data (80 pings at a 3.5 second interval) every 6 minutes while deployed. The data obtained between April 2003 and June 2004 indicated that 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).

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 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).

Temperature

The annual cycle of surface and bottom water temperatures in Nantucket Sound encompasses a range of about 45 °F (7 °C), from nearly 30 ^{o}F (-1 °C) in the winter to as high as 75 ^{o}F (24 °C) in the late summer (Bumpus et al., 1973). 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, the gradient is 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 61 to 66 ^{o}F (16 to 19 °C) (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 are in the range of 32 to 35.6 ^{o}F (0 to 2 °C), and become warmer with distance from the Cape Cod and Nantucket shorelines.

Site specific water temperature data was collected using an ADCP at the SMDS between April 2003 and September 2004. The ADCP was configured to collect 280 seconds of water temperature data every

6 minutes while deployed. During this period, the recorded water temperature varied from 30.2 °F (-1 °C) (recorded in February) to 72.5 °F (22.5 °C) (recorded in August).

Sediment Distribution

Nantucket Sound generally contains sand-sized marine sediments, with localized patches of clay, silt, gravel and/or cobbles and intermittent boulders. The sediments were derived from material originally transported from upland areas during glacial and post-glacial processes, and are now continually sorted and reworked by tidal, current, wave and storm actions. Shallow marine sediments were collected in vibracores and benthic grabs during 2001, 2002, and 2005 for the site of the proposed action (Horseshoe Shoal). Visual analysis of sediments within the 0- to 2-foot (0- to 0.61 m) depth range beneath the seabed indicates the presence of fine- to coarse-grained sands in areas of relatively shallow bathymetry, with fine to silty sands and silts predominating in deeper surrounding waters. This distribution is consistent with the higher-energy marine environments typically found in shallower waters, where finer sediments are winnowed away by current and wave action. The fines then settle out and deposit in the surrounding lower-energy deeper water areas.

Medium-grained sands predominate atop the U-shaped Horseshoe Shoal, with fine-grained sands found in the east-opening embayment. Localized fractions of silt, gravel and/or cobbles, consistent with glacial drift may also be present in the area. Fine to silty sands were encountered in the deeper water portions surrounding the shoal area.

A geophysical survey across Horseshoe Shoal conducted in 2001 identified areas of sand waves, especially in the south central portion of the shoal. The sand wave crests were oriented generally in a north-south direction, with long period wavelengths ranging from 100 to 600 ft (30.5 to 183 m). Short period sand waves are located between the larger crests. The average sand wave height was 4 to 5 ft (1.2 to 1.5 m), but waves as high as 15 ft (4.6 m) were found. The size of the sand waves attest to the dynamic shallow water environment on Horseshoe Shoal. The symmetry of the sand waves indicates migration to the east or west, depending on where they formed on the shoal. In other areas of the shoal, the majority of the seafloor contained few significant features and smooth sandy bottoms. Additional geophysical surveys conducted in 2005 generally confirmed earlier findings (see Section 4.1.1.2 of this final EIS for additional detail).

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

Sediment Quality

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

Sediment Transport

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 (see Report No. 4.1.1-9).

Generally the analysis found that active sediment transport occurs on Horseshoe Shoal, even 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 for typical conditions.

Bed load transport 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 (see Report No. 4.1.1-2). It is also expected since 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.

Spring tidal currents initiate approximately 20 percent more transport than mean tidal currents, and wind-driven currents from a sustained 15 knot (7.7 m/s) westerly wind have a similar effect by comparison. 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 of the proposed action, sediment transport rates can increase as much as one hundred fold, even for typical swells propagating from the Atlantic Ocean (e.g., four to five foot height with an eight 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.

More recent evaluations (Report No. 4.1.1-3) used the methodology of van Rijn (1993) to calculate bedload sediment flux on Horseshoe Shoal to be between 0.18 and 25 ft^3 (0.005 and 0.7 m^3) per day. Based on the information contained in available studies, it was estimated that the sand waves on Horseshoe Shoal migrate at a rate of 3.3 to 9.8 ft (1 to 3 m) per year. These analyses indicate that Horseshoe Shoal is a dynamic sediment transport environment under existing conditions.

3.2 Biological Environment

This section describes the biological environment of Nantucket Sound, and includes subsections on submerged aquatic vegetation (SAV), the plankton community, benthic communities, and commercial fisheries. Information was drawn from published literature and from studies conducted by the applicant. The following description of the biological environment of Nantucket Sound provides a basis for understanding the biological and ecological conditions that make these areas desirable as habitat for fish species.

SAV

Seagrass beds and other SAV provide habitat for many species of benthic invertebrates and fish. Below is a summary of SAV conditions at the WTG Array site (Horseshoe Shoal) and in nearshore Lewis Bay.

SAV on Horseshoe Shoal

Groundtruthing of SAV beds on Horseshoe Shoal was performed to investigate several areas where previous side-scan sonar observations indicated the potential presence of SAV beds. The major goal of this study was to determine presence or absence, and to qualitatively assess the composition of SAV in these areas of variable side-scan sonar returns. The field survey was conducted on July 25, 2006.

The vegetative composition within the study area was found to consist primarily of attached red (*Grinnellia americana*, *Dasya pedicellata* and *Gracillaria tikvahiae*), and green (*Codium fragile*, *Ulva lactuca*) macro-algae. Of the 20 observation points, only one location included patches of eelgrass (*Zostera marina*). Of the species identified above, only *C. fragile* is not native to New England waters.

The data collected during this investigation indicates that while there is significant SAV present on Horseshoe Shoal, it is primarily macro-algae and not seagrass. Many of the macro-algae observed are considered seasonal, beginning its growth in early to mid-summer and disappearing by late August (Hillson, 1982; Kingsbury and Sze, 1997; Villard-Bohnsack, 2003). Of the species observed, *G. americana* is potentially the most likely responsible for the variable side-scan sonar readings collected during previous 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 50 centimeters (cm) in length within a single summer growth season (Hillson, 1982). These algae would potentially show as an irregularity on side-scan sonar surveys during the summer growth season, and is likely the reason for the original variable sonar returns. For additional details on the methodology and results please see Report No. 4.2.2-1.

SAV in Lewis Bay

The MassDEP Wetlands Conservancy Program has mapped 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. 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 program conducted in 2001 and 2003. Staff at the MassDEP Wetlands Conservancy Program indicated that the mapped SAV bed had not changed much in size between 1995 and 2001 (Costello 2002).

A field investigation was performed on July 1, 2003 to determine the extent of the mapped SAV bed in the vicinity of the proposed submarine transmission cable route and to modify the proposed route accordingly to avoid direct impacts to SAV near Egg Island. SAV was identified by Woods Hole Group by diving and through visual observations. It was determined that the SAV was eelgrass (*Zostera marina*). See Report No. 4.2.2-2 for more detail and for a map showing the extent of the mapped eelgrass bed. Results of the field work indicate that the submarine transmission cable system would be no closer than 70 ft (21.3 m) from the edge of the eelgrass bed located near Egg Island.

Plankton Communities

Plankton refers to those plants (phytoplankton) and animals (zooplankton) that cannot maintain their distribution against the movement of water masses. Individual plankters are generally very small or microscopic; however, organisms such as jellyfish are often considered with the plankton community. Review of the scientific literature suggests that little information exists describing the plankton communities of Nantucket Sound. Their abundance and distribution is of particular interest since, in the case of phytoplankton, they form the base of the marine food web. Phytoplankton dynamics in all waterbodies, including those of Nantucket Sound are controlled by a suite of variables including light, temperature, nutrients, grazing by higher trophic level organisms and species interactions. Physical characteristics of the water column such as turbulence, stratification, and current patterns are also likely to influence patterns of species distribution.

Sherman et al. (1988) describes the phytoplankton community for the southern New England shelf area. Although, not specific to Nantucket Sound, the findings for this larger area are likely to be generally applicable to the Sound. Sherman et al. (1988) noted that in southern New England waters during February and March, small diatoms including *Leptocylindricus danicus*, *Skeletonema costatum* and *Thalassiosira nordenskioldii* predominate out to the 164 foot (50 m) isobath. In April an increase in *Phaeocystis pouchetti* is sometimes observed. Other widespread species include *Nitzchia seriata*, *Rhizosolenia hebetate* and *R. shrubsoleia*. Small naked dinoflagellates including several *Gymnodinium* species are abundant. The diatom *Skeletonema costatum* appears to dominate the shelf area from August through October. Falkowski et al. (1988) suggested that phytoplankton assemblages in the region may receive seed populations from Georges Bank and Nantucket Shoals which may be modified by biological and physical processes rather than simply advected along the shelf. As waters move southwest along the shelf, phytoplankton species may be cropped, grow differentially, or sink forming distinct assemblages.

Various zooplankton species serve as prey for higher trophic level organisms such as fish. The zooplankton communities within Nantucket Sound are likely to contain copepods, euphausiids, amphipods, isopods and a variety of other planktonic crustaceans. Fish eggs and larvae resulting from the spawning of local fish populations would also be found in within the plankton community of Nantucket Sound.

Benthic Communities

Based on literature reviewed, the most abundant benthic fauna taxa in Nantucket Sound are crustaceans and mollusks, followed by polychaete worms (annelids) (Sanders, 1956; Wigley, 1968; Pratt, 1973; Theroux and Wigley, 1998). Among the crustaceans, amphipods are reported to be by far the most abundant. Bivalves are reported to be the most abundant and diverse of the mollusks in Nantucket Sound (Pratt, 1973). MDMF (2001a) reports that a heavily populated area of northern quahog (*Mercenaria mercenaria*) exists in the shoals east of Horseshoe Shoal. The annelid fauna is also reported to be diverse (Theroux and Wigley, 1998). Maurer and Leathem (1981) identified 333 species of polychaete worms in sandy sediments from Georges Bank and Nantucket Shoals. Many of these species occur in the deeper waters of Nantucket Sound. Biomass is reported to be lower in shallow areas of Nantucket Sound, including the Preferred Site (Theroux and Wigley, 1998). This is most likely due to the unstable sandy sediments in these shallow waters. These polychaetes are a favorite prey of several species of demersal fish, particularly winter flounder (*Pseudopleuronectes americanus*) (Buckley, 1989).

A total of 90 benthic samples were collected from the waters of Nantucket Sound between 2001 and 2005. Samples were collected from each of the dominant benthic habitats present within the site of the proposed action and within surrounding sites during a variety of seasons. Overall, benthic community composition documented as part of the 2001, 2002, 2003, and 2005 studies, was consistent with data reported in earlier studies of Nantucket Sound, Georges Bank, and the Southern New England Shelf (Sanders, 1956; Wigley, 1968; Pratt, 1973; Theroux and Wigley, 1998). These previous studies found the benthic community of Nantucket Sound to have a lower than average invertebrate diversity as compared to the rest of the Southern New England Shelf; however, density and biomass was found to be relatively high. This is not surprising, as it is understood that only a limited number of taxa are capable of withstanding the shifting, sandy substrates characteristic of these shallower waters. Consequently, these productive shallow water habitats are able to support greater densities of each successfully adapted organism.

There is natural variability in most benthic communities, since these communities are constantly subjected to a combination of physical and biological factors which results in a high degree of environmental variability (Sanders, 1958; Zajac, 1998). It also follows that a high sample-to-sample variability was found in total invertebrate abundance. This supports the conclusion of earlier research that also revealed the benthic community of Nantucket Sound to be highly variable from season to season and location to location (Wigley, 1968). It is believed that the patchy nature of “microhabitats” (defined as the specific combination of habitat elements in the place occupied by an organism for a specific purpose) in terms of such parameters as depth, substrate type, temperature, light penetration, food availability, shelter, disturbance, currents, and predation could be the reason for such variability (Sanders, 1956; DeLeuw et al., 1991; Howe et al., 1997).

Based on the benthic samples collected for this assessment, an obvious link between depth, sediment type, and macroinvertebrate community diversity was observed. However, the data also showed that there was no such link between these variables and overall macroinvertebrate abundance. The only microhabitat variable investigated that was shown to significantly affect macroinvertebrate abundance was the presence or absence of sand waves. The unstable sand wave environment was predominantly inhabited by more motile organisms capable of avoiding the shifting sands (e.g., some amphipod taxa or the tanaid *Leptognathia caeca*) or by organisms that could burrow out from beneath them once they became buried (e.g., the bivalve *Tellina agilis*, Nematoda, Oligochaeta, or a number of the Polychaeta). Interestingly, *T. agilis* was the only shellfish (bivalve or gastropod) that was found in any sample taken from a sand wave. Gosner (1978) describes *T. agilis* as a mobile and actively burrowing bivalve.

Finally, based on the samples collected from the meteorological tower support pilings, it is clear that the support pilings were colonized by a benthic community that is very similar in nature to the surrounding sea floor community. Although several new taxa were recorded from the pilings that had not been observed during previous samplings from mud, sand, or gravelly bottom, these new taxa are very likely the result of the natural dispersal of species from other fixed hard substrate habitat within the site of the proposed action such as boulders or larger rocky shoals. The final EIS Section 4.2.5 has more detailed information on benthic habitats and communities in Nantucket Sound.

Commercial Fisheries

Nantucket Sound supports a commercial fishery for diverse species of fish (e.g., Atlantic mackerel, summer flounder, black sea bass, scup, menhaden, winter flounder, butterfish, king whiting, tautog and bluefish) and invertebrates (e.g., squid, lobster and conch). Types of gear that commercial fishermen use in Nantucket Sound for harvesting commercially sought species include otter trawls, dredges, fish weirs, seines, a variety of traps/pots, and hand lines. The Federal and State agencies monitor certain commercial fishing activities in Nantucket Sound. The NOAA Fisheries monitors federally-permitted commercial fishing activities in all U.S. coastal states. The Commonwealth of Massachusetts monitors state-permitted commercial fishing activity for certain fisheries and gear types in its coastal waters. The 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 for characterization of commercial fisheries in the Nantucket Sound locale.

Federal (NOAA Fisheries) and MDMF agencies that are responsible for collecting commercial fishing data in Massachusetts collect independent and overlapping data. Mechanisms for collecting the data vary. The NOAA Fisheries uses trip-based reports where species and gear types are surveyed, but only for Federal permit holders. The MDMF uses an annual report system and gear-based reports. Although MDMF issues permits to all commercial fishermen and seafood dealers in Massachusetts, the catch and effort data are collected only for certain fisheries (striped bass, lobster, fish wier, gillnet, fish-pot (conch, scup and sea bass) and shellfish. The data should be evaluated and considered separately and can be used for a sense of types of commercial fishing activity taking place in Nantucket Sound and proportion of different fisheries landings.

NMFS Commercial Fisheries Data

In order to summarize commercial landings in the United States, NOAA Fisheries has divided the U.S. coastline into statistical sampling areas. Waters that are around Cape Cod and the Islands have been designated as NOAA Fisheries Statistical Area 538 and Nantucket Sound is designated as Sub-area 075.

Since 1994, a mandatory reporting system has been in practice and includes fishermen submitting logbooks of VTR detailing their catch. The commercial landings data include fish species and invertebrates such as squid, lobster, shrimp, and crabs. Total federally-reported landings appear to have increased from 1994 through 2000. Between 2001 and 2004 landings have fluctuated.

From 1994 through 2004, approximately 9.6 million lbs (4,354,487 kg) of commercial landings that are subject to federal VTR reporting were harvested from Nantucket Sound. The top twenty species of fish and invertebrates include *Loligo* squid, Atlantic mackerel, channeled whelk, summer flounder, black sea bass, scup, unidentified squid species, unidentified whelk species, unidentified clam species, menhaden, knobbed whelk, *Ilex* squid, winter flounder, sea scallop, butterfish, ocean quahog, king whiting, tautog, hard clam, and bluefish. The squid landings (approximately 3.6 million lbs (1,632,932 kg)) accounted for approximately 49 percent of federally-reportable fish and squid landings during the eleven year period. Types of gear that commercial fishermen use in Nantucket Sound for harvesting these commercial species include otter trawls, dredges, fish weirs, seines, a variety of traps/pots, and hand lines. Federal VTR data report that greatest landings during the time period of 1994 to 2004 were from otter trawls for bottom fish. Fish weirs, fish pot/traps, and hand lines also produced significant catches. The gill net fishery, fish weir fishery, and fish pot fishery for scup and sea bass are monitored independently by MDMF. Report No. 4.2.5-5 presents the detailed analyses of commercial fisheries data presented in this section.

MDMF Commercial Fisheries Data

The MDMF studies and monitors marine resources that fall under its jurisdiction. This includes monitoring of commercial harvest of marine fish, lobster, and other shellfish. There are several programs involved in managing marine resources and harvesting these resources. The Fisheries Dependent Investigation Project involves monitoring 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 fisheries that are "regulated." For monitoring fishery resources in Massachusetts' waters, coastal water areas are divided into statistical areas. Nantucket Sound is assigned a designation as Area 10, which is equivalent to NMFS Sub-area 075. Catch reports are required to be submitted by commercial fishermen for fisheries that include striped bass, the fish weir fishery, the gill net fishery, shellfish, lobster, and the fish pot fishery (sea bass, scup and conch). Report No. 4.2.5-5 presents detailed information regarding these data.

Total landings in Nantucket Sound from the fish weir fishery from 1990 to 2004 are estimated to be 13.7 million lbs (6,214,215 kg). The highest landings from fish weirs were reported in 1990 (1.4 million lbs (635,029 kg) with the lowest reported in 2003 (184 thousand lbs [83,461 kg]). Species commonly reported from fish weirs include Atlantic mackerel, squid and scup. Numbers of fishermen that report use of fish weirs on state catch reports ranged from 3 to 5 from 1992 through 2004. The fifteen-year total state-reported landings for these species in Area 10 are as follows: Atlantic mackerel (5.8 million lbs [2,630,836 kg]; mean = 385,688 lbs/yr [174,945 kg/yr]), squid (4.7 million lbs [2,131,884 kg]; mean = 315,121 lbs/yr [142,936 kg/yr]), and scup (1.6 million lbs [725,748 kg]; mean = 105,571 lbs/yr [47,886 kg/yr]). Over the 15-year period, squid have shown a downward trend in total landings from fish weirs. Atlantic mackerel landings have fluctuated over the years peaking to an annual high of 876,160 lbs (397,419 kg) in 1997 and then declining between 7 to 530 thousand lbs (3.2 to 240 thousand kg) from 1998 through 2004. Scup landings peaked in 1992 (334 thousand lbs [151,500 kg]), declined to low landings in 1996 through 1998, and had a slight upward trend from 1999 through 2004.

The state-permitted gill net fishery does not make up a large component of state-reported landings in Nantucket Sound. For the time period of 1990 to 2004 gill net landings were reported during five years including 1992, 1993, 1995, 1999 and 2002. One commercial gill net license was issued for the area in

1992, 1995, and 1999. Three fishermen reported using gillnets in the area in 1993. There were no fishermen reporting use of gill nets in the remaining years.

Both scup and 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 sea bass in Nantucket Sound has varied over the years with a high of 38 in 1991 and a low of 18 in 1998. Total sea bass landings using fish pots from 1990 through 2004 were approximately 2.8 million lbs (1,270,059 kg). Seasonally, sea bass landings are highest in May and June and average more than 72,000 lbs (32,659 kg) per year in May and more than 49,000 lbs (22,226 kg) per year in June over the 15-year period.

Reporting of catch for harvesting of scup from fish pots has only been required since 1994. As for sea bass, many commercial fishermen are licensed to harvest scup from fish pots. For 1994 there were 49 fishermen fishing pots for scup in MDMF 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. The total scup landings that came from fish pots during the timeframe of 1994 to 2004 were approximately 1.3 million lbs (589,670 kg). On a seasonal basis, scup landings are highest in June, averaging approximately 53,000 lbs (24,040 kg) per year from 1994 through 2004.

The striped bass fishery is another important fishery in Nantucket Sound. This species is harvested commercially and recreationally in the region. The striped bass commercial fishery is a hook and line fishery only with the season going from mid July until the quota is filled (MDMF, 2005). The MDMF monitors striped bass that are landed and sold to market in addition to those caught and released, or kept by fishermen. On a seasonal basis, striped bass landings sold to market were greatest in the month of July with a mean of 25,324 lbs (11,487 kg) per year landed from 1990 to 2004. By September, amounts of striped bass landed and sold to market are lower with a mean of 814 lbs (369 kg) per year from 1990 through 2004. The total striped bass landings (based on those sold to market) for Nantucket Sound from 1990 through 2004 were estimated to be approximately 574,000 lbs (260,362 kg). Total annual landings from 1990 through 1994 did not exceed 15,000 lbs (6,804 kg). During 1995 through 1998, the annual landings of striped bass increased to a high of 80,000 lbs (36,287 kg) in 1998. Annual landings then decreased to below 50,000 lbs (22,680 kg) in 1999 and 2001. From 2002 through 2004 annual landings of striped bass have fluctuated up and down.

Survey of Commercial and Recreational Fishing Activities – 2005

Information was gathered by survey from recreational and commercial fishermen, shellfish officers, harbor masters, bait and tackle shop employees and a commercial fish dealer. Commercial fishermen and a fish dealer were contacted by mail and were asked for voluntary participation in the survey. Some of these individuals were interviewed in person with most being interviewed by phone in late summer and early fall of 2005. Information on categories and numbers of interviewees, 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 fishing commercially (Report No. 4.2.5-6). 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 squid in primarily during April, May and 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 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) under management of surveyed respondents commercially 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 also targeted bluefish and tautog concurrently. Out of the two commercial hook and line boats 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 noted fishing for sea bass in the Horseshoe Shoal locale with 80 percent reporting such fishing occurred outside the Horseshoe Shoal locale. Details on the findings of this survey are presented in the *Survey of Commercial and Recreational Fishing Activities* (Report No. 4.2.5-6).

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 commercial fishermen 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 commercial fishermen 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. Details on the findings of this survey are presented in the *Survey of Commercial and Recreational Fishing Activities* (Report No. 4.2.5-6).

4.0 FEDERALLY MANAGED SPECIES

4.1 Species with EFH Designation

During preparation of the Final Environmental Impact Report (FEIR), the applicant prepared an EFH Assessment (Report No. EFH-1). Report No. EFH-1 along with other sources of information was used for the preparation of this document.

In the Northeast, NOAA Fisheries works with the New England Fishery Management Council (NEFMC) and the Mid-Atlantic Fishery Management Council (MAFMC) to define essential habitat for key species in New England coastal waters, including those of Nantucket Sound. The Management Councils and NOAA Fisheries designates EFH for numerous species in association with a mapped grid of 10 x 10 minute squares, which covers all marine habitat along the United States coast. The site of the proposed action lies within four of these 10 x 10 minute squares in Nantucket Sound (Figure 1). This location requires the investigation of 17 federally managed fish and three federally managed invertebrate species for this assessment (Table 1). Additional life stages for certain species may be present in an area, however, EFH for those specific life stages may not have been designated. Specific habitat conditions may indicate that EFH does not exist for some of these species or life stages in the proposed action area.

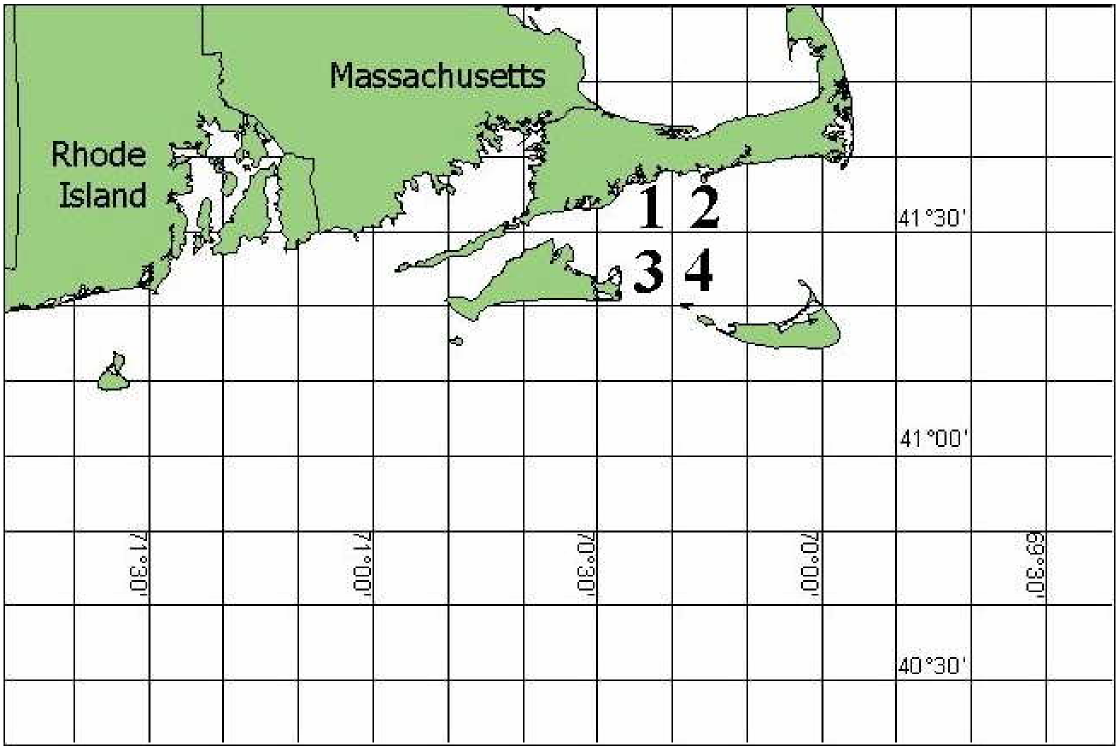


Figure 1. NOAA Fisheries 10 x 10 minute squares for EFH designation

Table 1.
Summary of specific life stage EFH designations for species in the NOAA Fisheries designated 10 x 10 minute squares encompassing the Preferred Site in Nantucket Sound (NOAA 2007)

Common Name	Scientific Name	Eggs	Larvae	Juveniles	Adults	Spawning Adults
Atlantic cod	*Gadus morhua*				X	
Scup	*Stenotomus chrysops*	n/a	n/a	X	X	
Black sea bass	*Centropristis striata*	n/a	X	X	X	
Winter flounder	*Pseudopleuronectes americanus*	X	X	X	X	X
Summer flounder	*Paralichthys dentatus*	X	X	X	X	
Windowpane	*Scophthalmus aquosus*				X	X
Yellowtail flounder	*Limanda ferruginea*			X*		
Atlantic butterfish	*Peprilus triacanthus*	X	X	X	X	
Atlantic mackerel	*Scomber scombrus*	X	X	X	X	
King mackerel	*Scomberomorus cavalla*	X*	X*	X	X	
Spanish mackerel	*Scomberomorus maculates*	X*	X*	X	X	
Cobia	*Rachycentron canadum*	X*	X*	X	X	
Blue shark	*Prionace glauca*				X	
Shortfin mako shark	*Isurus oxyrhinchus*			X		
Bluefin tuna	*Thunnus thynnus*			X*	X*	
Little skate	*Leucoraja erinacea*			X	X	
Winter skate	*Leucoraja ocellata*			X	X	
Long-finned squid	*Loligo pealei*	n/a	n/a	X	X	
Short-finned squid	*Illex illecebrosus*	n/a	n/a	X	X	
Surf clam	*Spisula solidissima*	n/a	n/a	X	X	

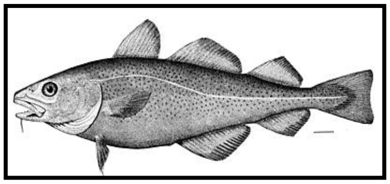
*Detailed EFH descriptions (see Section 4.2 of this document) reveal that EFH is not designated for this species/lifestage in Nantucket Sound.

4.2 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 in Table 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 Massachusetts Division of Marine Fisheries (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 and are summarized in Appendix A. Additionally, Report No. 4.2.7-2 provides life history descriptions for additional groups of species that have the potential to occur in Nantucket Sound that have not been covered in this EFH Assessment. These additional groups of species include the Atlantic States Marine Fisheries Commission (ASMFC) managed species (including such species as bluefish and striped bass), and commercially or recreationally important species. Report No. 4.2.7-2 also provides more extensive and detailed information on the forage characteristics of the EFH species. Life history characteristics for each EFH species are presented below.

4.2.1 Demersal Species

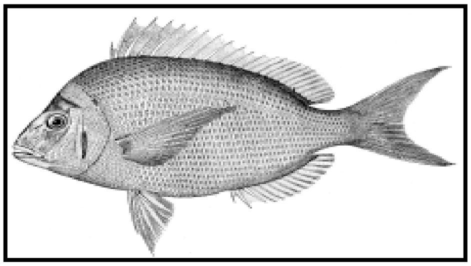
4.2.1.1 ATLANTIC COD (Gadus morhua)



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 °C) (Heyerdahl and Livingstone, 1982). MDMF 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 to130 m), but are sometimes found at mid-water depths (Fahay et al., 1999). They can tolerate a temperature range from near freezing to 68 °F (0 °C to 20 °C), but prefer temperatures below 50 °F (10 °C) (Fahay et al., 1999). Adult cod can also exist in a wide range of oceanic salinities. 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).

4.2.1.2 SCUP (Stenotomus chrysops)



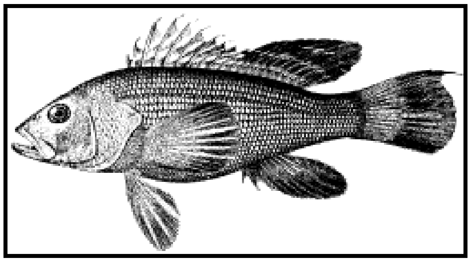
JUVENILES. For juvenile scup, EFH is designated as the demersal waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH in inshore waters includes all estuaries and bays where juvenile scup were identified as being common, abundant or highly abundant in the ELMR database for the "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). Sand waves of varying heights are present in the center and southern half of Horseshoe Shoal and in several smaller fields located in the proposed action area. Additional details on sand waves can be found in the Section 4.1.1.2.1 of the main body text of this document. Generally, juvenile scup can be found in water temperatures greater than 45 °F (7.2 °C) and in salinities greater than 15 ppt.

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 ^{o}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 ^{o}C) bottom isotherm, their lower preferred limit (Neville and Talbot, 1964). With rising temperatures in the spring, scup return inshore (Steimle et al., 1999b). Off Massachusetts, surveys (MAFMC, 1996a) showed that most adults were collected in spring through fall at depths less than 98 ft (30 m).

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). Fish species preyed on by scup include butterfish and sand lance (Bowman et al., 2000).

4.2.1.3 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 ^{o}C) (55 to 70 °F (13 to 21 ^{o}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. Lower salinity estuarine waters are generally avoided. Studies (Steimle et al., 1999a) have reported larvae in high salinity areas of southern New England in August and September. When larvae become demersal, they are generally found on structured inshore habitat.

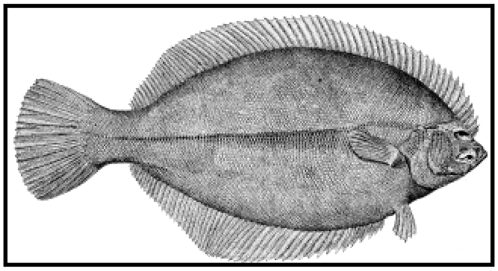
JUVENILES. The demersal waters over the continental shelf, from the Gulf of Maine to Cape Hatteras, are designated as EFH for juvenile black sea bass. EFH in inshore waters includes all estuaries where juvenile black sea bass were identified as being common, abundant or highly abundant in the ELMR database 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). This is generally in the high salinity area (Mercer, 1989) of most estuaries along the coast from southern Cape Cod to North Carolina (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). They are not common on open, unvegetated sandy intertidal flats or beaches (Allen et al., 1978). Juvenile black sea bass can generally be found in water temperatures greater than 43 °F (6.1 °C) with salinities greater than 18 ppt.

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. NEFSC spring surveys (Steimle et al., 1999a) in Massachusetts found adults were most common at bottom temperatures between 52 to 57 °F (11 to 14 °C), and at depths less than 16 ft (5 m). NEFSC fall surveys found them most often at bottom temperatures between 57 and 73 °F (14 to 23 °C), and at depths less than 49 ft (15 m). They were generally more abundant in the spring. Adult black sea bass can also be found in estuaries from May through October, although they prefer deeper bays and coastal waters (Steimle et al., 1999a). 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. Adult black sea bass prefer water temperatures greater than 48 °F (8.8 °C) (JCAA-ASMFC, 2006). Wintering adults are generally offshore, south of New York to North Carolina in water temperatures greater than 43 °F (6.1 °C) and in association with sandy and shelly substrate. 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., 1999), 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).

4.2.2 Demersal Groundfish Species

4.2.2.1 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. Generally (with the exception of Georges Bank and Nantucket Shoals), winter flounder eggs can be found in water temperatures below 50 °F (10 °C), depths less than 16 ft (5 m), and a salinity range between 10 and 30 ppt. The optimal salinity range for egg survival is between 15 and 35 ppt (Buckley, 1989). Extremes in salinity may lower egg hatching success (Buckley, 1989). The optimal temperature range for egg survival is between 32 and 50 °F (0 to 10 °C) (Williams, 1975). NMFS has appointed specific regions of EFH in the proposed action area for this life stage, and eggs may be subject to random burial from settling sediment during construction and decommissioning activities.

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. Generally, the following habitat conditions exist for larvae: sea surface temperatures below 59 °F (15 °C), depths less than 19.7 ft (6 m), and a salinity range between 4 and 30 ppt. Extremes in salinity may lower larval survival success (Buckley, 1989). NMFS has appointed specific regions of EFH in the proposed action area for this life stage.

"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 yr.) (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). NEFSC bottom trawl surveys (Pereira et al., 1999) found YOY were most common in water temperatures below 82.4 °F (28 °C) (65.3 °F (18.5 °C) preferred range) (Casterlin and Reynolds, 1982), depths from 0.3 to 32.8 ft (0.1 to 10 m), and a salinity range between 5 and 33 ppt. NMFS has appointed specific regions of EFH in the proposed action area for this life stage.

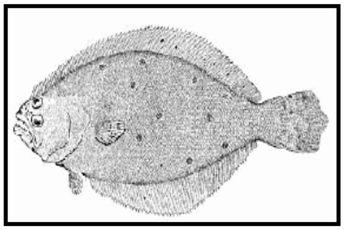
AGE 1+ JUVENILES. Winter flounder juveniles older than 1 year have EFH in bottom habitats with a substrate of mud or fine-grained sand on Georges Bank, the inshore areas of the Gulf of Maine, southern New England, and the middle Atlantic south to the Delaware Bay. Juveniles are common, abundant, and 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). NEFSC bottom trawl surveys (Pereira et al., 1999) found the majority of juveniles were at water temperatures of 39.2 to 44.6 °F (4 to 7 °C) in spring and 51.8 to 59 °F (11 to 15 ^{o}C) in fall. In general, water temperatures below 77 °F (25 ^{o}C), depths from 3.3 to 164 ft (1 to 50 m), and a salinity range between 10 and 30 ppt is preferred. NMFS has appointed specific regions of EFH in the proposed action area for this life stage.

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). NEFSC surveys (Pereira et al., 1999) in Massachusetts found adults were plentiful at water temperatures of 41 to 55.4 °F (5 to 13 °C) in spring and at 48.2 to 55.4 °F (9 to 13 °C) in the fall. Water temperature seems to be the most important factor determining seasonal distribution of adults (McCracken, 1963). As a general rule, the warmer the water gets, the farther offshore winter flounder will migrate. Generally, adult winter flounder exist in water temperatures below 59°C (12 to 15 °C preferred range) (McCracken, 1963), depths from 3.3 to 328 ft (1 to 100 m), and a salinity range between 15 and 33 ppt. MDMF (2001b) survey trawls on Horseshoe Shoal have found winter flounder are relatively common during spring and rare during fall within the proposed action area. NMFS has appointed specific regions of EFH in the proposed action area for this life stage.

S<u>PAWNING</u> A<u>DULTS.</u> 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). Salinity preferences range from 31 to 32.5 ppt in inshore waters, and at slightly higher salinities between 32.7 and 33 ppt on Nantucket Shoals and Georges Bank (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 ^{o}C) (McCracken, 1963). NEFSC surveys (Pereira et al., 1999) in Massachusetts found the bulk of the adult catch occurred in water 82 ft (25 m) or less in the spring (during and just after spawning) and 82 ft (25 m) or deeper in the fall (prior to spawning). NMFS has appointed specific regions of EFH in the proposed action area for this life stage.

<u>Forage species.</u> 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). Winter flounder are also known to break off clam siphons that protrude from the sand (Collette and Klein-MacPhee, 2002).

4.2.2.2 SUMMER FLOUNDER, OR FLUKE (*Paralichthys dentatus*)



E<u>GGS.</u> 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. Eggs are most often collected at depths of 98.4 to 229.7 ft (30 to 70 m) in the fall, as far down as 361 ft (110 m) in the winter, and from 32.8 to 98.4 ft (10 to 30 m) in the spring (Packer et al., 1999).

L<u>ARVAE.</u> 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. Larvae are generally most abundant nearshore (39.3 to 164 ft [12 to 50 m] from shore) at depths between 32.8 and 252.6 ft (10 to 77 m). 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). NEFSC surveys (Packer et al., 1999) in Massachusetts revealed a seasonal shift in juvenile occurrence with bottom temperature. In the spring, most juveniles occur at a range of temperatures from 48.2 to 57 °F (9 to 14 °C), while in the fall they occur at temperatures from 50 to 70 °F (15 to 21 °C). 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.

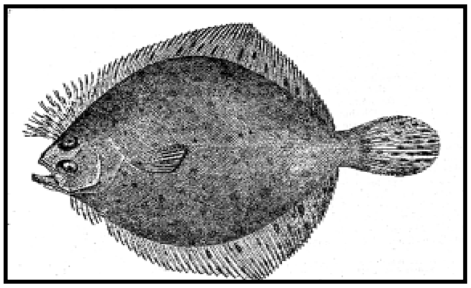
ADULTS. Like juveniles, EFH for adult summer flounder also consists of the demersal waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH in inshore waters includes all estuaries where adult summer flounder were identified as being present (rare, common, abundant or highly abundant) 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). MDMF 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 and alternative sites in Nantucket Sound.

The salinity range of preference for adults appears to be greater than 15 ppt, and they are generally observed in the higher salinity portions of estuaries (Packer et al., 1999). However, 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). They occur in an extremely varied temperature range, between 35.6 and 80.6 °F (2 and 27 °C) (Packer et al., 1999). NEFSC surveys (Packer et al., 1999) in Massachusetts revealed a seasonal shift in adult occurrence with bottom temperature. In the spring, most adults occur at a range of temperatures from 42.8 to 62.6 °F (6 to 17 °C), while in the fall they occur at temperatures from 57.2 to 69.8 °F (14 to 21 °C). Tagging studies (Poole, 1962; Lux and Nichy, 1981) on flounder released off Long Island and southern New England revealed that adults usually began seaward migrations in September or October. Some evidence suggests that older adults may remain offshore all year (Festa, 1977).

Habitat Area of Particular Concern (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. If native species of SAV are eliminated, exotic species should be protected because of functional value. However, all efforts should be made to restore native species. SAV noted on Horseshoe Shoal was primarily attached red and green macro-algae with limited patches of eelgrass. Eelgrass beds have been found in portions of Lewis Bay and additional details on SAV conditions at the WTG Array site (Horseshoe Shoal) and in nearshore Lewis Bay are presented in Section 3.2 of this Appendix.

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).

4.2.2.3 WINDOWPANE (Scophthalmus aquosus)

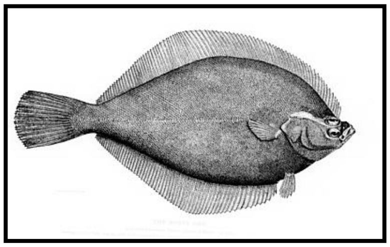


ADULTS. For adult windowpane, EFH exists in bottom habitats with a substrate of sand, fine-grained sand, or mud around the perimeter of the Gulf of Maine, on Georges Bank, southern New England, and the middle Atlantic south to the Virginia-North Carolina border. Adults are common and abundant in Nantucket Sound throughout the year as indicated by the ELMR database. Adults occur primarily on sand substrates off southern New England (Chang et al., 1999). NEFSC surveys (Chang et al., 1999) in Massachusetts revealed most adults were caught south of Cape Cod during spring at bottom temperatures of 48.2 to 55.4 °F (9 to 13 °C) and at depths less than 49.2 ft (15 m). This high aggregation in spring suggests spawning or feeding activities. In fall, adults were more widely distributed across this range, preferring bottom temperatures of 48.2 to 66.2 °F (9 to 19 °C) and depths less than 98.4 ft (30 m). Generally, adult windowpane can be found in water temperatures below 80.2 °F (26.8 °C), depths of 3.3 to 328 ft (1 to 100 m), and a salinity range between 5.5 and 36 ppt. MDMF (2001b) survey trawls on Horseshoe Shoal have found windowpane are relatively common during spring and rare during fall within the proposed action area. NMFS has appointed specific regions of EFH in the proposed action area for this life stage.

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). Generally, the following habitat conditions for spawning adults exist: water temperatures below 70 °F (21 °C), depths from 3.3 to 246 ft (1 to 75 m), and a salinity range between 5.5 and 36 ppt. 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 afore mentioned 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).

4.2.2.4 YELLOWTAIL FLOUNDER (*Limanda ferruginea*)

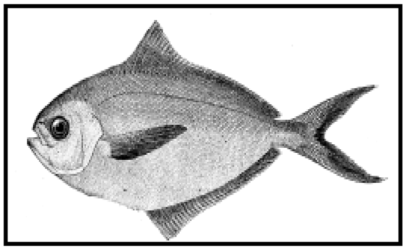


JUVENILES. EFH for juvenile yellowtail flounder is not present in Nantucket Sound. EFH for juvenile yellowtail flounder is designated as bottom habitat with a substrate of sand or sand/mud on Georges Bank, the Gulf of Maine, and the southern New England shelf south to Delaware Bay. Juveniles are rare and absent from Nantucket Sound throughout the year as indicated by the ELMR database. The concentration of juvenile yellowtail flounder is seasonal in coastal waters east of Cape Cod, with small numbers caught in the shoal waters south of Martha's Vineyard and Nantucket Island (Johnson et al., 1999). MDMF trawl surveys found the highest concentration of juveniles at temperatures ranging from 35.6 to 57.2 °F (2 to 14 °C) (39.2 to 46.4 °F (4 to 8 ^{o}C) preferred range) in spring and 41 to 62.6 °F (5 to 17 ^{o}C) (46.4 to 51.8 °F (8 to 11 ^{o}C) preferred range) in fall; depths ranged from 16.4 to 246 ft (5 to 75 m) (Johnson et al., 1999). Despite the seasonal aggregation of juveniles in the northern Cape Cod area (Cape Cod Bay) during spring and fall, they migrate away from coastal areas during the latter half of the fall season (Johnson et al., 1999). Juveniles can also be found in a salinity range from 32.4 to 33.5 ppt. According to more site-specific EFH assessments, NMFS has not appointed specific regions of EFH in Nantucket Sound for this life stage (NEFMC, 1998).

Forage species. Adult yellowtail flounder feed chiefly on amphipods and polychaetes (Bowman et al., 2000), although they also eat cnidarians, small crabs and shrimps, mysid shrimps, cumaceans, ispods, mollusks, echinoderms, and some small fishes such as sculpins and sand lance (Collette and Klein-MacPhee 2002). Studies in (Johnson et al., 1999) indicate that yellowtail flounder adults eat mostly crustaceans while juveniles eat mostly polychaetes.

4.2.3 Coastal Pelagic Species

4.2.3.1 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). Generally, eggs are found in water temperatures of 51.9 to 62.9 °F (11.1 to 17.2 ^{o}C) and from shore to 6,562 ft (2000 m), but concentrated in depths less than 656.2 ft (200 m).

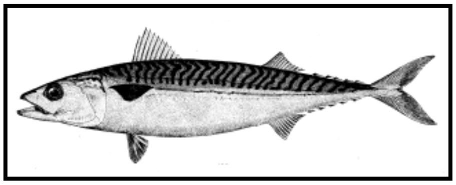
LARVAE. EFH for Atlantic butterfish larvae consists of those pelagic waters over the continental shelf, from the Gulf of Maine to Cape Hatteras. EFH for inshore waters includes the "mixing" (0.5 to 25.0 ppt) and "seawater" (>25 ppt) portions of all the estuaries where Atlantic butterfish larvae were 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). During the NEFSC MARMAP ichthyoplankton surveys (Cross et al., 1999), butterfish larvae were mostly found at water temperatures of 48.2 to 66.2 °F (9 to 19 ^{o}C), depths less than 393.7 ft (120 m), and at salinities ranging from estuarine to full strength seawater.

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. During NEFSC surveys (Cross et al., 1999) in Massachusetts, butterfish juveniles were found at depths ranging from 16.4 to 262.4 ft (5 to 80 m), but most were collected between 32.8 and 114.8 ft (10 and 35 m). Bottom water temperatures ranged from 48.2 to 59 °F (9 to 15 ^{o}C) in the spring and 44.6 to 71.6 °F (7 to 22 ^{o}C) in the fall. The surveys also revealed that juvenile catches were 1-2 times greater in fall than in spring.

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. NEFSC surveys (Cross et al., 1999) in Massachusetts revealed adults were found at depths ranging from 16.4 to 262.4 ft (5 to 80 m), but most were collected between 32.8 and 164 ft (10 and 50 m). Bottom water temperatures ranged from 48.2 to 59 °F (9 to 15 ^{o}C) in the spring and 44.6 to 71.6 °F (7 to 22 ^{o}C) in the fall. In the spring, adults were caught primarily south of Cape Cod and in Buzzards Bay, while in fall they were caught primarily in Buzzards Bay, Massachusetts Bay, and around Cape Ann. Several studies in Cross et al. (1999) also reveal adults will inhabit the high salinity and mixed salinity zones of most estuaries from the Gulf of Maine to Florida. MDMF (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).

4.2.3.2 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. Atlantic mackerel eggs are not yet compiled in the ELMR database. Eggs are pelagic in waters over 34 ppt (Fritzsche, 1978). They can generally be found in water temperatures between 41 and 72.9 °F (5 and 22.7 ^{o}C) and at depths of 98.4 to 229.7 ft (30 to 70 m). Yet, 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. They can generally be found in water temperatures between 42.9 and 71.9 °F (6.1 and 22.2 °C) and at depths of 36.1 to 465.9 ft (11 to 142 m). Yet, 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. NEFSC surveys (Studholme et al., 1999) in Massachusetts revealed juveniles were most abundant at 51.8 °F (11 °C) in spring and 48.2 to 55.4 °F (9 to 13 °C) in fall, at depths of 32.8 and 164 ft (10 and 50 m) in spring and 82 and 196.8 ft (25 and 60 m) in fall. Occurrences of juvenile Atlantic mackerel were highest in the fall (Studholme et al., 1999). Yet, 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 NEFSC surveys (Studholme et al., 1999) in Massachusetts, adults were most abundant at 57.2 °F (14 °C) water temperatures during the spring, with only a few recorded in the fall at 50 and 59 °F (10 and 15 °C). Individuals in spring were caught at depths of 32.8 ft (10 m) while the few in fall were caught at 164 ft (50 m). Yet, based on a Massachusetts coastal zone survey in Studholme et al. (1999), adults in Nantucket Sound occur only randomly.

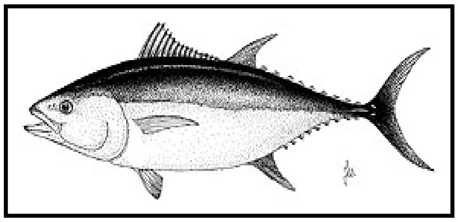
Forage species. These fish are opportunistic feeders that swallow prey whole. Food is acquired either through filter feeding or pursuit of individuals (Studholme et al., 1999). Juveniles will eat mostly small crustaceans such as copepods, amphipods, mysid shrimp (*Mysis spp.*), and decapod larvae (Studholme et al., 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).

4.2.4 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.

4.2.4.1 BLUEFIN TUNA (Thunnus thynnus)

EFH is not present for the designated lifestages of bluefin tuna in the proposed action area; however, a brief summary of the location of EFH for each lifestage is provided below.

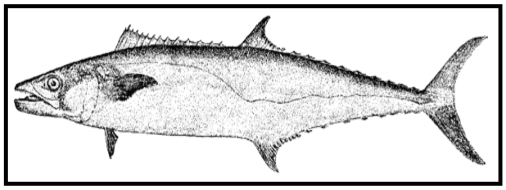


JUVENILES/SUBADULTS. EFH for juvenile/subadult bluefin tuna consists of all inshore and pelagic waters warmer than 53.6 °F (12 °C) off the Gulf of Maine and Cape Cod Bay, from Cape Ann, MA (~42.75 °N) east to 69.75 °W, continuing south to and including Nantucket Shoals at 70.5 °W to Cape Hatteras (~35.5 °N), in pelagic surface waters warmer than 53.6 °F (12 °C), between the 82 and 328 foot (25 and 200 m) isobaths. EFH is not located in the proposed action area.

ADULTS. Adult bluefin tuna are found from Newfoundland to Brazil (Buck, 1995), but have EFH in the pelagic waters of the Gulf of Maine from the 164 foot (50 m) isobath to the EEZ boundary, including the Great South Channel, then south of Georges Bank to 39°N from the 164 foot (50 m) isobath to the EEZ boundary. EFH is not located in the proposed action area.

Forage species. This species is an open-water predator, chasing and feeding upon schooling species such as herring, mackerel, silver hake and squid (Ross, 1991) as well other pelagic species such as menhaden and sand lance (Marine Fisheries, 2005). Specifically, South of Cape Cod they have been found to prey intensively on menhaden (Collette and Klein-MacPhee, 2002).

4.2.4.2 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.

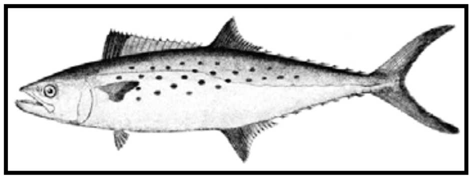
LARVAE. King mackerel larvae have been collected near the surface on the Atlantic coast from May through October in surface water temperatures of 78.8 to 87.8 °F (26 to 31 °C) and in a salinity range of 26 to 37 ppt (Godcharles and Murphy, 1986). Larval distribution indicates that spawning occurs in 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 harvested from state-reportable fish weirs in Nantucket Sound according to the DMF 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 °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 harvested from state-reportable fish weirs in Nantucket Sound according to the DMF 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).

4.2.4.3 SPANISH MACKEREL (Scomberomorus maculatus)



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

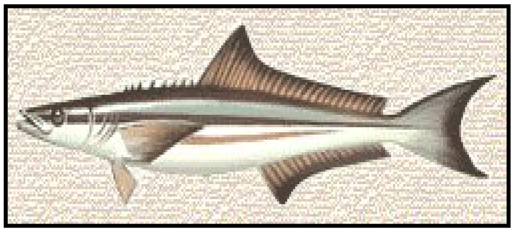
LARVAE. Larvae are generally found in surface water temperatures of 67.2 to 85.6 °F (19.6 to 29.8 °C) and in a high salinity range of 28.3 to 37.4 ppt or higher (Fishbase, 2006). There is no documentation found of larval Spanish mackerel occurring at any regularity within the proposed action area, which has physical properties that are inconsistent with its preferred habitat characteristics.

JUVENILES. Apparently, some juvenile Spanish mackerel use estuaries as nursery grounds, but most stay nearshore in open beach waters (Godcharles and Murphy, 1986). The waters surrounding the mouths of freshwater rivers are most often avoided (VTCMI, 1996). All life stages of Spanish mackerel are primarily seen in waters above 63.9 °F (17.7 °C) and within a salinity range of 32 to 36 ppt (Godcharles and Murphy, 1986). There is no documentation found of juvenile Spanish mackerel occurring at any regularity within the proposed action area, which has physical properties that are inconsistent with its preferred habitat characteristics. However, extremely low landings (4 pounds (1.81 kilograms)) were reported in one out of eleven years of federally-reportable commercial VTR data for Spanish mackerel in Nantucket Sound. Additionally, small numbers of this species were reported from NOAA recreational charter VTR data (one individual between 1994 and 2004) and from NMFS MRFSS surveys (6 individuals between 1990 and 2004). A small amount of landings have also been reported harvested from state-reportable fish weirs in Nantucket Sound according to the DMF commercial database.

ADULTS. Spanish mackerel adults range from the Gulf of Maine to the Yucatan Peninsula, but are considered uncommon north of the Chesapeake Bay (The Hudson River Almanac, 1995). Migratory patterns are driven by water temperature, preferring a range of 69.9 to 87.9 °F (21.1 to 31.1 °C). All life stages of Spanish mackerel are primarily seen in waters above 63.9 °F (17.7 °C) and within a salinity range of 32-36 ppt (Godcharles and Murphy, 1986). They will spawn off Virginia over a long period between late spring and late summer (Chesapeake Bay Program, 2006). There is no documentation found of adult Spanish mackerel occurring at any regularity within the proposed action area, which has physical properties that are inconsistent with its preferred habitat characteristics. However, extremely low landings (4 lb (1.81 kg)) were reported in one out of eleven years of federally-reportable commercial VTR data for Spanish mackerel in Nantucket Sound. Additionally, small numbers of this species were reported from NOAA recreational charter VTR data (one individual between 1994 and 2004) and from NMFS MRFSS surveys (6 individuals between 1990 and 2004). A small amount of landings have also been harvested from state-reportable fish weirs in Nantucket Sound according to the DMF commercial database.

Forage species. Spanish mackerel juveniles and adults are primarily pelagic carnivores and principally piscivorous (Godcharles and Murphy, 1986) although lesser quantities of pandalid and penaeoid shrimps and squids are also consumed (Collette and Klein-MacPhee, 2002). Anchovies, menhaden, and alewives are the dominant fish prey of this species (Bowman et al., 2000).

4.2.4.4 COBIA *(Rachycentron canadum)*



EGGS. Most cobia eggs are found in offshore waters adjacent to the mouth of the Chesapeake Bay and south to Virginia in late June through mid-August (Shaffer and Nakamura, 1989; VIMS, 2006). There is no documentation found of cobia eggs occurring at any regularity within the proposed action area, which has physical properties that are inconsistent with its preferred habitat characteristics.

LARVAE. Most cobia larvae are found in offshore waters adjacent to the mouth of the Chesapeake Bay and south to Virginia (Shaffer and Nakamura, 1989) where they may inhabit the sargassum. There is no documentation found of cobia larvae occurring at any regularity within the proposed action area, which has physical properties that are inconsistent with its preferred habitat characteristics.

JUVENILES. Studies in Shaffer and Nakamura (1989) show early juvenile cobia will move inshore and inhabit coastal areas, near beaches, river mouths, barrier islands, lower reaches of bays and inlets, or bays of relatively high salinities. Yet there is no documentation found of cobia juveniles occurring at any regularity within the proposed action area, which has physical properties that are inconsistent with its preferred habitat characteristics. In addition, none of the agency databases documented the occurrence of cobia in Nantucket Sound (see Appendix A).

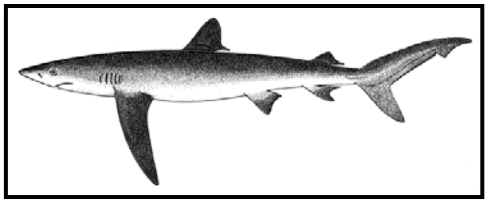
ADULTS. Cobia adults range from Cape Cod to Argentina. They undergo extensive migrations from overwintering grounds near the Florida Keys to more northerly spawning/feeding grounds in spring and summer months (Richards, 1967). Cobia can be found in high salinity bays, estuaries, and seagrass habitat 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. In addition, none of the agency databases documented the occurrence of cobia in Nantucket Sound (see Appendix A).

Forage species. Cobia are opportunistic predators, their diet includes portunid crabs (swimming crabs), a variety of small pelagic and epibenthic fishes, and squid (Boschung et al., 1997; Chesapeake Bay Program, 2004).

4.2.5 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.

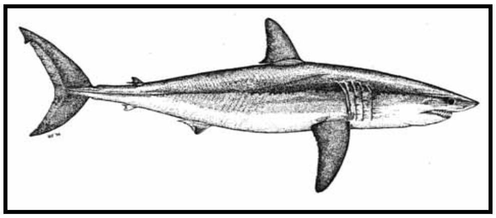
4.2.5.1 BLUE SHARK (Prionace glauca)



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). Generally, blue sharks can be found in a temperature range of 44.6 to 80.6 °F (7 to 27 °C) (prefer 55.4 to 64.4 °F (13 to 18 °C)) and depths from 6.6 to 656.2 ft (2 to 200 m) (Street, 1999). 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).

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, bluefish and red and silver hakes are the most important, with mackerel, menhaden, Atlantic herring, and blueback herring also being common forage items (Ross, 1991).

4.2.5.2 SHORTFIN MAKO SHARK (Isurus oxyrhinchus)

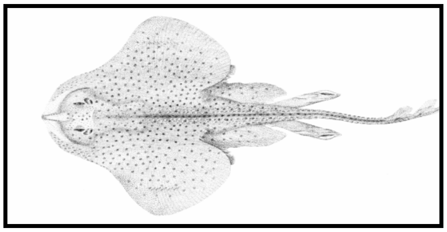


LATE JUVENILES/SUBADULTS. EFH exists for juvenile shortfin mako sharks in the offshore waters between Cape Cod and Onslow Bay, NC, between the 82 and 6,652 foot (25 and 2000 m) isobaths; and extending west between 38°N and 41.5°N to the EEZ boundary. It is most commonly seen in offshore waters from Cape Cod to Cape Hatteras (Passarelli et al., 2006). Generally, shortfin mako sharks are found in a temperature range between 62.6 and 68 °F (17 and 20 °C) (Passarelli et al., 2006) and at depths from the surface to at least 492 ft (150 m) (Shark Trust, 2007). 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).

4.2.6 Skates

4.2.6.1 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). Skates are known to remain buried in depressions during the day and are more active at night.

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.

Based on the Massachusetts spring and fall inshore trawl surveys (Reid et al., 1999), juvenile little skate were found at depth ranges between 1 and 65m, with most occurring between 19.6 and 82 ft (6 and 25 m) during both seasons. In the spring, juveniles were found in waters ranging from 37.4 to 60.8 °F (3 to 16 ^{o}C), with the greatest percentages between 46.4 and 53.6 °F (8 and 12 ^{o}C). In the fall, they were found in waters ranging from 41 to 71.6 °F (5 to 22 ^{o}C), with the highest percentages between 60.8 and 64.4 °F (16 and 18 ^{o}C). NEFSC bottom trawl surveys (Reid et al., 1999) indicated that juvenile little skate were found at salinities ranging from 26 to 36 ppt, with the majority between 32 and 33 ppt during both spring and fall.

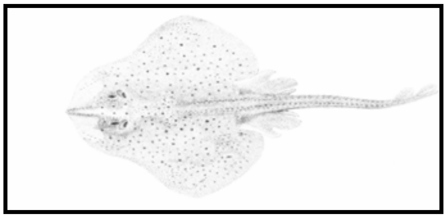
ADULTS. EFH for adult little skate has been designated for the areas of highest relative abundance for this species based on NMFS trawl survey (1963-1999) and ELMR data. Only habitats with sandy, gravelly, or mud substrates that occur within these areas of high abundance are designated as EFH (Packer et al., 2003b). Skates are known to remain buried in depressions during the day and are more active at night.

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).

Based on the Massachusetts spring and fall inshore trawl surveys (Reid et al,. 1999), adult little skate were found at depth ranges between 3.3 and 246 ft (1 and 75 m), with most occurring between 19.7 and 98.4 ft (6 and 30 m) in the spring and between 19.7 and 82 ft (6 and 25 m) in the fall. In the spring, adults were found in waters ranging from 37.4 to 60.8 °F (3 to 16 ^{o}C), with the majority occurring between 41 and 53.6 °F (5 and 12 ^{o}C). In the fall, they were found in waters ranging from 41 to 69.8 °F (5 to 21^{o}C), with peaks occurring at 50 °F (10 ^{o}C) and 60.8 °F (16 ^{o}C). NEFSC bottom trawl surveys (Reid et al., 1999) indicated that adult little skate were found at salinities ranging from 29 to 36 ppt, with the majority occurring at 33 ppt in the spring and between 32 to 33 ppt in the fall.

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).

4.2.6.2 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). Skates are known to remain buried in depressions during the day and are more active at night.

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.

Based on the Massachusetts spring and fall inshore trawl surveys (Reid et al., 1999), juvenile winter skate were found at depth ranges between 3.3 and 246 ft (1 and 75 m), with most occurring between 19.7 and 82 ft (6 and 25 m) during both seasons. In the spring, juveniles were found in waters ranging from 37.4 to 59 °F (3 to 15 ^{o}C), with the greatest percentages between 46.4 and 53.6 °F (8 and 12 ^{o}C). In the fall, they were found in waters ranging from 41 to 69.8 °F (5 to 21 ^{o}C), with peak occurrences between 60.8 and 64.4 °F (16 and 18 ^{o}C). NEFSC bottom trawl surveys (Reid et al., 1999) indicated that juvenile winter skate were found at salinities ranging from 28 to 35 ppt, with the majority between 32 and 33 ppt during both spring and fall.

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). Skates are known to remain buried in depressions during the day and are more active at night.

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.

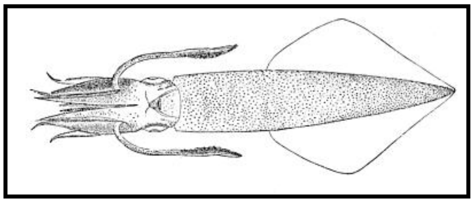
Based on the Massachusetts spring and fall inshore trawl surveys (Reid et al., 1999), adult winter skate were found at depth ranges between 3.3 and 246 ft (1 and 75 m), with most occurring between 19.7 and 65.6 ft (6 and 20 m) during the spring and between 19.7 and 82 ft (6 and 25 m) during the fall. In the spring, adults were found in waters ranging from 35.6 to 60.8 °F (2 to 16 ^{o}C), with the greatest percentages between 42.8 and 53.6 °F (6 and 12 ^{o}C). In the fall, they were found in waters ranging from 41 to 66.2 °F (5 to 19 ^{o}C), with peak occurrences at 50 °F (10 ^{o}C) and a minor peak between 59 and 60.8 °F (15 and 16 ^{o}C). NEFSC bottom trawl surveys (Reid et al., 1999) indicated that adult winter skate were found at salinities ranging from 30-36 ppt, with the majority occurring at 33 ppt in the spring and at 32 ppt in the fall.

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 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).

4.2.7 Invertebrates

4.2.7.1 LONG-FINNED SQUID *(Loligo pealei)*

Information related to long-finned squid eggs and larvae may be found in Report No. 4.2.7-2, Additional Life History for Commercially and Recreationally Important Species and Forage Species.



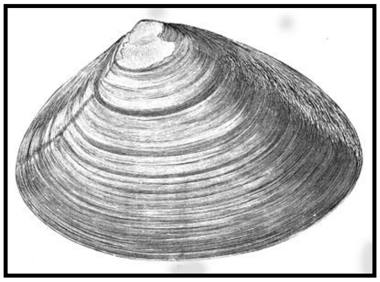
JUVENILES, OR "PRE-RECRUITS." EFH for long-finned squid pre-recruits consists of those pelagic waters over the continental shelf from the Gulf of Maine to Cape Hatteras. Older juveniles (sub-adults) are thought to overwinter in deeper waters along the edge of the continental shelf (Black et al., 1987). Based on NEFSC surveys (Cargnelli et al., 1999b) in Massachusetts, most juveniles were found in a temperature range of 50 to 55.4 °F (10 to 13 ^{o}C) in spring and 59 to 68 °F (15 to 20 ^{o}C) in fall. The preferred depth range was constant at 32.8 to 49.2 ft (10 to 15 m). 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). Based on NEFSC surveys (Cargnelli et al., 1999b) in Massachusetts, most adults were found in a temperature range of 50 to 55.4 °F (10 to 13 ^{o}C) in spring and 60.8 to 68 °F (16 to 20 ^{o}C) in fall. Preferred depths were 32.8 to 49.2 ft (10 to 15 m) in spring and 32.8 to 98.4 ft (10 to 30 m) in fall. Seasonal distribution is virtually identical to that of the juveniles (Cargnelli et al., 1999b). The spring and fall surveys noted above for juveniles reported presence around Nantucket Island and Martha's Vineyard. MDMF (2001b) survey trawls on Horseshoe Shoal have found long-finned squid are abundant year round within the proposed action area. It should be noted that Brodziak and Macy (1996) suggest that this species has a life span of less than one year.

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 in (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).

Information related to fish species that target squid as food may be found in Report No. 4.2.7-2, Additional Life History for Commercially and Recreationally Important Species and Forage Species.

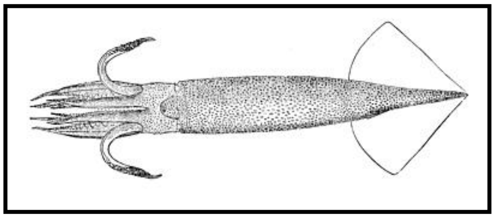
4.2.7.2 SURF CLAM (*Spisula solidissima*)



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 1 m (3.3 ft) below the water/sediment interface, from the Gulf of Maine and eastern Georges Bank throughout the Atlantic Exclusive Economic Zone (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. They are also found in a salinity range greater than 28 ppt, and in areas where bottom temperature rarely exceeds 77 °F (25 ^{o}C) (Cargnelli et al., 1999c).

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).

4.2.7.3 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. The preferred bottom temperature range is less than 50.4 °F (10.2 ^{o}C), a surface temperature range between 58.3 and 68.9 °F (14.6 and 20.5 °C), and a depth range from 88.6 to 180.4 ft (27 and 55 m). Juveniles were also taken in a salinity range of 34 to 37 ppt. 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). The preferred bottom temperature range is between 50.4 and 55.2 °F (10.2 and 12.9 °C), a surface temperature range around 69.1 °F (20.6 °C), and a depth range from 328 to 1200.8 ft (100-366 m). 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.

5.0 ANALYSIS OF IMPACTS

This section describes potential impacts to EFH and species with EFH designation during the construction, operation, maintenance, and decommissioning of the proposed action. Potential impacts that could occur during these phases are presented in Sections 5.1 through 5.8.

5.1 Impacts to Benthic EFH

The potential impacts to benthic EFH are described based on the anticipated duration of the impact. While the total area of the seafloor encompassed within the boundaries of the proposed action is large, there are extensive areas that would not be impacted by the proposed action activities and there is an even smaller area that would be impacted in a long-term manner. For example, while more than 80 mi (129 km) of cable jetting are proposed in order to bury the cables, these areas would be temporarily disturbed, whereas each of the monopile locations represent a long-term alteration of the benthic habitat.

5.1.1 Permanent Impacts to Benthic EFH

The total permanent direct area of benthic habitat disturbance from construction activities is summarized in Table 5.3.2-3 of this final EIS. Permanent benthic habitat loss would result from installation of the WTG and ESP monopile foundations. This permanent loss due to occupation of structures would be approximately 0.67 acres (2,711 m^2) or 0.0042 percent of the total proposed action area (Table 5.3.2-3 of this final EIS). Similar habitat conditions are present in areas adjacent to the site of the proposed action. Mitigation for this occupation of benthic habitat is discussed in Section 6.0 below.

5.1.2 Temporary Impacts to Benthic EFH

The installation of the scour control, inner-array cables, and two submarine transmission cable circuits would physically displace sediment at specific locations. The total temporary direct area of benthic habitat disturbance from construction activities is summarized in Table 5.3.2-3 of this final EIS.

Temporary impacts to benthic habitat would result from jet plow embedment of the inner-array cables, jet plow embedment of the two circuits comprising the 115 kV offshore transmission cable system, and installation of the scour protection devices, as well as from vessel positioning, anchoring, and anchor cable sweep associated with construction (see Table 5.3.2-3 of this final EIS). This disturbance could total up to approximately 820 acres (3.3 km^2) (5.1 percent of the total proposed action area) with scour protection mats and rock armor or conservatively 866 acres (3.5 km^2) (5.4 percent of the total proposed action area) with rock armoring at all 130 turbines and the ESP (see Table 5.3.2-3 of this final EIS) and would be temporary except for the benthic habitats altered by the footprint of the foundations and the scour protection. Decommissioning-related impacts would be short-term and localized and are expected to be similar to impacts during construction (see Section 5.3.2.5.1 of this final EIS).

The temporary benthic habitat disturbance of between 820 and 866 acres (3.3 to 3.5 km^2) from construction could result in the temporary loss of functions and values provided by the benthic EFH. Impacts during construction are temporary, occur over small areas, and the benthic habitat is expected to recover thus restoring the functions and values to EFH and EFH fish species. After the installation, 1.96 acres would remain altered by the addition of scour mats and 8.75 acres from rock armoring. If scour mats prove less effective in some areas they would be replaced by rock armor with the extreme case being all scour protection accomplished with rock armoring. In this case, 47.82 acres (0.19 km^2) of seabed would be altered(see table 5.3.2-3 of this final EIS).

Benthic EFH provides some of the following functions and values to fish: habitat, shelter, nursery/spawning habitat, and food source. However, as described in more detail below, impacts during construction are temporary and occurring over relatively small areas. Also, the benthic habitat is expected to recover thus restoring the functions and values to EFH and EFH fish species.

The impact from jet plow embedment of the inner-array cables and two submarine transmission cable circuits would be temporary, with suspended sediments anticipated to settle and refill cable trenches and areas immediately surrounding the cable trenches shortly after embedment (see Section 5.3.1.1 of this final EIS and Report No. 4.1.1-2 for more detail). Impacts associated with cable installation barge positioning, anchoring, anchor line sweep, and the pontoons on the jet plow device would also be localized and temporary. Impacts from anchor line sweep has the greatest areal impact, but would primarily affect the sediments to a depth of between 3 and 6 inches (7.6 and 15.2 cm) (Algonquin Gas Transmission Company, 2000) and impacts would be minimized through the use of mid-line buoys. Anchoring locations would have disturbances to the sediment to a depth of 4 to 6 ft (1.2 to 1.8 m) at each anchor deployment, leaving a temporary irregularity to the seafloor with localized mortality of infauna. While numerous anchor re-positionings would occur, the cumulative area is still small (see Section 5.3.2.5 of this final EIS). Jet plow embedment would directly disturb sediments to a depth of approximately 8 ft (2.4 m), deeper than the anchoring or anchor line sweep depth disturbances.

Modeling was used (see Section 5.3.1.1 of the final EIS and Report No. 4.1.1-3) to estimate seabed scar recovery from jet plow cable burial operations. Using the assumption that 3 percent of the sediments in the jetted cross section could be injected back into the water column and that the coarse sediment volume is returned to the trench, it was estimated that the dimensions of the scar left along the cable routes would be 6 ft (1.8 m) wide and from 0.75 to 1.7 ft (0.23 to 0.53 m) deep. Information from a number of relevant studies at similar sites was reviewed, and by applying those findings to site specific conditions for Nantucket Sound and Horseshoe Shoal, approximate recovery times were estimated for the trench scars. The methodology of van Rijn (1993) was used to calculate bedload sediment flux at core locations along the proposed 115kV transmission cable route outside the Horseshoe Shoal area. Bedload transport rates at the core locations range from 0.18 to 25 ft^3/day per foot (0.017 to 2.3 m^3/day per meter) of seabed. Together the flux rates from Horseshoe Shoal and the rates calculated using the method of van Rijn represent the range of sediment flux throughout Nantucket Sound. Based on these transport rates, recovery rates for jetting scars along the transmission cable route are estimated to be between 0.2 and 38 days. Recovery of jetting scars on Horseshoe Shoal is anticipated to occur within a few days. Areas of low wave and tidal current energy and a predominately mud bottom such as Lewis Bay are typically dominated by suspended sediment load. In these areas it is likely that seabed scars from cable burial would last months or until a major storm (hurricane or major nor'easter) occurs. Deposition rates in estuaries in southern New England typically range from 0.079 to 0.79 in/yr (0.2 to 2.0 cm/yr) (King, 2005). See Section 5.3.2.5 of this final EIS and Report No. 4.1.1-3 for further details on benthic substrate recovery.

Egg and larval stages of demersal EFH species would be temporarily affected by benthic habitat disturbance if present during the time of year of construction. EFH species with pelagic eggs and larvae would be less affected by temporary benthic habitat disturbance. The temporary displacement of benthic habitat would also likely result in the mortality and/or dispersal of some benthic organisms (i.e., prey for some EFH species) in the footprints of the construction activities, thereby temporarily disrupting feeding for some benthic-oriented juvenile and adult EFH species in the area. Pelagic-oriented juveniles and adult EFH species would be less affected by permanent and temporary benthic habitat loss. The greatest areal impacts to surficial benthic habitat and therefore to early demersal life stages and benthic prey species of demersal adults and juvenile EFH species would occur from anchor positioning and anchor line sweep. However, as discussed in more detail in Section 5.3.2.7 of this final EIS, the total anticipated temporary impact to the upper sediments from anchoring would comprise less than 4.2 percent of the total proposed action area. Therefore, sufficient food base is expected to be available for foraging fish species. In fact, during actual construction disturbance activities affecting the benthos, injured or displaced benthic invertebrates may provide a short-term opportunity for increased feeding by fish.

In the nearshore Lewis Bay environment, benthic EFH could be directly affected by the HDD borehole end dredging activities within Lewis Bay; however, dredging would be limited to a volume of 840 yd^3 (642.2 m^3) and would be contained within the cofferdam. The area enclosed by the cofferdam would be approximately 2,925 ft^2 (272 m^2), a minimal area compared to surrounding habitat in Lewis Bay. The dredged sediments from within the cofferdam pit would be temporarily removed and replaced upon completion of the submarine transmission cable system. Due to the limited and contained nature of the HDD installation activities within the cofferdam and the limited area affected by the backfilling of the dredged material, no substantial impacts to benthic EFH are expected. These activities would not be required during decommissioning. See Section 2.3.6 of this final EIS for more detailed information on HDD construction and installation methodologies.

In general, the disturbance of the benthic environment from construction would be short-term and localized because many benthic invertebrate species are capable of opportunistically recolonizing benthic sediments after disturbance (Hynes, 1970; Rosenberg and Resh, 1993; Rhoads et al., 1978; Howes et al., 1997). It has been found that benthic communities that are adapted for survival in high-energy environments would recover more quickly following disturbance (Dernie et al., 2003). The naturally dynamic environment of the proposed action area is already subject to fluctuations in suspended sediment concentrations at the seabed/water interface as a result of relatively strong tidal currents and wind and storm generated waves, particularly in shoal areas. Consequently, benthic organisms in the proposed action area are adapted to relatively wide fluctuations in water column suspended sediment concentrations and are not expected to be substantially impacted by short-term sediment resuspension associated with construction and decommissioning. Therefore, affected benthic invertebrate populations are expected to recover as quickly as they are capable of reproducing. Many shellfish species generally spawn on an annual basis; however, depending on the water temperature and time of year, shellfish may spawn more than once per year. Therefore, benthic invertebrate populations at the proposed action's site are expected to fully recover within a time period of 1 to 2 years (Byrnes et al., 2004; C-CORE, 1995; Hall, 1994; Newell et al., 1998; Rhoads and Germano, 1986; Rhoads et al., 1978; Whitlatch et al., 1998).

In addition, because benthic habitats similar to those in the proposed action area are present in Nantucket Sound, similar benthic communities (i.e., prey organisms) would be located in many areas and EFH species would be able to find suitable prey in areas adjacent to the proposed action area and other regions of the Sound. Pelagic species are likely to be able to occupy the water column in other parts of the Sound. As disturbed benthic habitat is recolonized by benthos, as discussed above, EFH species would resume foraging in those areas as prey items become more abundant. Therefore, impacts to EFH species from mortality or displacement of prey species would be expected to be minor.

During decommissioning activities, benthic EFH would be disturbed once again. Temporary impacts to that habitat would be similar to those described above. In addition, benthic communities that have recolonized sediments initially disturbed during construction, such as along the inner-array cable and two submarine transmission cable circuits and over the filled-in scour control mats, would be disturbed once again. Post-decommissioning recolonization is expected, and in the interim, EFH species in the proposed action area are likely to be able to find similar prey items in adjacent areas or in other areas of the Sound.

5.1.3 Temporary Impacts to Eelgrass Habitat in Lewis Bay

As discussed in Section 3.2 of this EFH Assessment, Section 4.2.2.4 of this DIES and Report No. 4.2.2-2, one SAV eelgrass bed has been mapped within Lewis Bay, located to the west of Egg Island in the Town of Barnstable. To avoid impacts to this habitat which also serves as EFH for several EFH species in the proposed action area (black sea bass, scup, summer flounder), the submarine transmission cable system would be no closer than 70 ft (21.3 m) from the edge of the eelgrass bed located near Egg Island.

In the area of the eelgrass bed in Lewis Bay, the bottom sediments are relatively coarse. Simulations of sediment transport and deposition from jet plow embedment predict that sediments suspended by the jet plow would fall along the route with bottom deposition predicted to be in the range of 0.04 to 0.1 inches (1.0 to 3.0 millimeters) at the western edge of the eelgrass bed (see Report No. 4.1.1-2). The majority of the eelgrass bed is predicted to experience little or no deposition as a result of the jet plow embedment operations. Suspended sediment concentrations in this area are predicted to be in the range of 50 to 500 mg/L, depending on proximity to the cable route. Suspended sediment concentrations of 10 mg/L are predicted to remain for approximately 9 to 18 hours after the jet plow has passed this point on the route. At the western end of the eelgrass bed, suspended sediment concentrations of 100 mg/L are predicted to remain for up to 4 hours. The full model simulation analysis is included as Report No. 4.1.1-2.

Many sessile or bottom-oriented aquatic organisms (including eelgrass) encounter some level of sedimentation under natural conditions as a result of tidal currents, waves, and storms. As a result, many organisms have morphological, behavioral, and/or physiological means of dealing with exposure to deposited sediments. Regrowth of seagrasses such as eelgrass can occur if sediment deposition only results in a light covering of sediment material and if the rhizome system is not damaged (USACE DOER, 2005). Since the majority of the eelgrass bed is expected to experience little or no deposition as a result of jet plow operations, it is anticipated that the natural means of seagrass adaptation to changing sedimentation conditions would allow the eelgrass bed to withstand the short-term jet plow operations that would pass the eelgrass bed.

5.1.4 Temporary Impacts to Submerged Aquatic Vegetation on Horseshoe Shoal

Potential impacts to SAV on Horseshoe Shoal as a result of the construction and decommissioning of the proposed action are expected to be limited in nature. Section 4.2.2.4 of this final EIS, Report No. 4.2.2-1 and Section 3.2 in this text summarize the extent of SAV within Horseshoe Shoal. Field surveys have shown the proposed action area to include only sparse areas of SAV. Most of the habitat surveyed within Horseshoe Shoal was shown to be bare sand and the areas that did include SAV assemblages were primarily comprised of macro-algae, not eelgrass. Impacts to the limited SAV assemblages in the proposed action area are expected from activities associated with installing the inner-array cables, the submarine transmission cable system, the WTGs, the ESP, and the scour control around the monopile foundations. Overall, these activities are anticipated to impact a total of 686 acres (2.7 km^2) of Nantucket Sound (see Table 5.3.2-3 in this final EIS for a detailed breakdown).

Impacts to SAV resulting from the above listed activities (including anchor cable sweep) are expected to be temporary and similar to impacts seen during coastal storm events. These impacts would include the damage and/or displacement of SAV found within the specific working areas for these individual components. The constantly shifting sands of Horseshoe Shoal results in a dynamic environment, where SAV is constantly buried by shifting sands or displaced by currents and wave action.

The only permanent impacts to SAV anticipated are those associated with the installation of the WTGs, ESP, and the scour protection (mats and rock armor). The physical presence of the monopile towers would result in a loss of available habitat within the tower footprint for the duration of the proposed action. Once installed however, the towers themselves would provide a substrate area greater than that being impacted for the attachment and subsequent growth of macro-algae.

Once construction has moved to a new site, natural re-colonization of the disturbed areas, by both eelgrass and macro-algae, should begin immediately. However, complete recolonization of disturbed areas by seagrass may take a decade or longer (Neckles et al., 2005), while macro-algae would recolonize considerably faster due to their fast growing nature and opportunistic growth strategies. Based upon the species composition observed during the ground-truthing field study (Report No. 4.2.2-2), it is expected that within 12-24 months of installation (Villard-Bohnsack, 2003), macro algae would have significantly re-colonized areas which previously supported these communities, as well as the monopile foundations of the WTGs.

5.1.5 Potential for Sediment Contamination of Benthic EFH

Recent studies indicate that sediments in the proposed action area are predominantly sand, and that chemical constituent concentrations are below established thresholds in applicable reference sediment guidelines. Specifically, all of the chemical constituents detected in sediment core samples obtained from the proposed WTG array site and along the submarine transmission cable route had concentrations below ER-L and ER-M marine sediment quality guidelines (Long et al., 1995) (see Section 4.1.6.3 of this final EIS). Therefore, the temporary and localized disturbance and suspension of these sediments during construction and decommissioning is not likely to result in increased incorporation of contaminants in the benthic substrate or at low trophic levels. EFH species are thus unlikely to experience increased bioaccumulation of contaminants via consumption of prey items or exposure to benthic substrate classified as EFH.

During the nearshore installation in Lewis Bay, the HDD operation would be designed to include a drilling fluid fracture or overburden breakout monitoring program to minimize the potential of drilling fluid breakout into waters of Lewis Bay. The drilling fluid would consist of water (approximately 95 percent) and an inorganic, bentonite clay (approximately 5 percent). Although it is anticipated that drilling depths in the overburden would be sufficiently deep to avoid pressure-induced breakout of drilling fluids through the seafloor bottom, a bentonite monitoring program would be implemented for the detection of possible fluid loss (see Section 2.3 of this final EIS). In the unlikely event of drilling fluid release, the bentonite fluid density and composition would cause it to remain as a cohesive mass on the seafloor in a localized slurry pile similar to the consistency of gelatin. This cohesive mass can be quickly cleaned up and removed by divers and appropriate diver-operated vacuum equipment; thereby minimizing any long-term impacts to EFH or EFH species. Short-term impacts would consist of the covering of benthic organisms in the immediate area of release. These activities would not be required during decommissioning and thus would not be an associated impact risk.

5.2 Impacts to Water Column EFH

5.2.1 Impacts to EFH from Degraded Water Quality

Construction activities associated with installing the monopile foundations, scour control mats/rock armor, and the inner-array cables and submarine transmission cable system would result in a temporary and localized increase in suspended sediment concentrations which could affect EFH that is defined as within the water column. Decommissioning-related impacts would be short-term and localized and are expected to be similar to impacts during construction. Elevated total suspended solids (TSS) can negatively impact the ability of some finfish to navigate, forage, and find shelter. The pile driving hammer and jet plow technology that would be used to install the monopile foundations and the submarine cables, respectively, were selected specifically for their ability to keep sediment disturbance to a minimum. Due to the predominant presence of fine to coarse-grained sand in Nantucket Sound, localized turbidity associated with construction or decommissioning is anticipated to be minimal and confined to the area immediately surrounding the monopiles, the inner-array cables, and the two submarine transmission cable circuits. Sediments disturbed by construction or decommissioning activities are expected to settle back to the sea floor within a short period of time (see Section 5.3.1.1 of this final EIS and Report No. 4.1.1-2 for more detail). In addition, the proposed action area 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. Therefore, marine organisms, including EFH species, in this area are accustomed to substantial amounts of suspended sediment and should not be substantially impacted by a temporary increase in turbidity from construction and decommissioning activities.

Simulations of sediment transport and deposition from jet plow embedment of the submarine transmission cable system and the inner-array cables were performed. These simulations, which used two models (HYDROMAP to calculate currents and SSFATE to calculate suspended sediments in the water column and bottom deposition from the jet plow operations), estimated the suspended sediment concentrations and deposition that could result from jet plow embedment of the cables. The full analysis is included as Report No. 4.1.1-2. The model results demonstrate that concentrations of suspended sediment in the water column resulting from jet plow embedment operations (i.e., concentrations above natural background conditions) are largely below 50 mg/L. The effect of grain size distribution is evident since the finer sediments present in portions of the Lewis Bay area, the area at the southern half of the north-south portion of the route, and the area just northwest of the ESP, remain in suspension longer due to higher silt and clay fraction. This results in larger predicted plume extents.

It is important to note that the suspended sediment concentration levels are short lived due to the tides flushing the plume away from the jetting equipment and the sediments rapidly settling out of the water column. To put the water column concentrations in perspective, Figure 4.5 in Report No. 4.1.1-2 shows the duration that a 10 mg/L excess (above background) suspended sediment concentration is seen. Most of the area shows duration of less than 3 hours after the jet plow has passed a given point along the route. In places along and immediately adjacent to the cable route, suspended sediment concentrations are predicted to remain at 100 mg/L for approximately 2 to 3 hours.

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

These TSS concentrations are still minimal when compared to the active bed load sediment transport known to exist in Nantucket Sound (between 45 and 71 mg/L under natural tidal conditions and up to 1,500 mg/L as a result of trawling operations. Sediment suspension during construction and decommissioning activities are not anticipated to result in long-term or environmentally significant elevations in water column TSS. Demersal eggs and larvae of EFH species in the immediate vicinity of construction and decommissioning activities may experience mortality or injury through burial and smothering. Pelagic eggs and larvae of EFH species may be temporarily affected or displaced from elevated TSS in the immediate vicinity of construction and decommissioning activities. Juvenile and adult EFH species are mobile and capable of moving away from disturbed areas and elevated TSS concentrations. Zooplankton or fish species may be temporarily affected or displaced in the immediate vicinity of the area of the activity; however, they are likely to rapidly return to these areas once construction in the specific area ceases or is completed.

In addition, existing benthic community structure in Nantucket Sound is influenced by the area's dynamic sediment transport regime that is subject to naturally high suspended sediment concentrations due to strong wind and tidal current conditions. Organisms that inhabit this area are accustomed to these background levels of suspended sediment and are not expected to be substantially impacted by the temporary TSS increase during construction or decommissioning. Benthic organisms living on or in these sandy sediments are adapted for mobility in sand and recovery from burial, and are expected to opportunistically recolonize the disturbed sediments from adjacent areas. Sedimentation and elevated TSS concentrations resulting from construction or decommissioning is expected to be localized and temporary, and not anticipated to permanently alter benthic communities in the proposed action area. EFH species should not be detrimentally affected by the temporary loss of benthic prey items due to sedimentation/elevated TSS concentrations during construction or decommissioning. Furthermore, since benthic habitat is similar throughout Nantucket Sound, EFH species are likely to be able to find suitable benthic habitat and prey items adjacent to the proposed action area or in other areas of the Sound. As disturbed benthic habitat is recolonized by benthos, EFH species would resume foraging in those areas as prey items become more abundant. No substantial impact to EFH species or their prey is expected as a result of temporarily elevated TSS levels caused by proposed action’s construction or decommissioning.

Sediment suspension during excavation of the HDD borehole ends in Lewis Bay is expected to be minimal since these activities would be contained within the cofferdam and the top of the sheet piles for the cofferdam would contain turbidity associated with dredging for the HDD borehole end transition. Therefore, no impacts to EFH species are expected to occur from the limited, contained sediment suspension during excavation of the HDD borehole ends in Lewis Bay. These activities would not be required during decommissioning.

5.2.2 EFH Species Mortality/Injury/Displacement

Construction/decommissioning is not expected to result in measurable direct mortality or injury to adult and juvenile pelagic EFH finfish species since these life stages are mobile in the water column, capable of avoiding or moving away from the disturbances associated with construction, and not as closely associated with the bottom as demersal finfish. Adult and juvenile demersal EFH finfish species and adult and juvenile benthic EFH invertebrate species in the direct path of bottom disturbing construction and decommissioning activities may experience some direct mortality or injury. During winter construction periods, demersal finfish may experience higher levels of injury or mortality since avoidance of anchors and anchor cables may be hampered due to sluggish response under cold water conditions. However, no measurable effects on populations would be expected. Displacement of juvenile and adult EFH finfish species is likely to be temporary and localized, as no stressor is likely to extend great distances or for long durations associated with any of the construction activities. Displacement of juvenile and adult EFH finfish species is likely to primarily result from increased turbidity.

Because they lack motility, demersal EFH eggs or larvae that lie within the direct footprint of construction disturbance would likely experience mortality. Demersal EFH eggs and larvae may also experience localized increases in physical abrasion, burial or mortality from elevated suspended sediments during construction. The greatest areal impacts to demersal eggs and larvae would occur from anchor positioning and anchor line sweep during construction. However, the total anticipated temporary impact to the upper sediments from anchoring would comprise less than 4.2 percent of the total proposed action area. Larvae in the latter stages of development are capable of some motility, which may allow for movement from the construction area. Pelagic EFH eggs and larvae are likely to be less affected than demersal early life stages since they are not as closely associated with the bottom; however, those in the immediate area of construction could experience some injury or mortality. Eggs within the water column would be transported by prevailing currents, with larvae being transported to a lesser degree. Predatory fish species, which may feed on larvae, may be temporarily displaced from the area as a result of disturbance during construction or decommissioning activities. Decommissioning-related impacts are expected to be similar to impacts during construction. The presence and abundance of demersal or pelagic eggs and larvae with designated EFH in the proposed action area during construction or decommissioning depends on the species and time of year (see Appendix B, Table B-1).

5.2.3 Potential Impacts from Impingement/Entrainment of Fish Eggs/Larvae from Vessel Water Withdrawals/Water Withdrawals Associated with Cable Jetting

Vessel water withdrawals during jet plow embedment of the cable systems are anticipated to be minimal, consisting only of periodic withdrawal of near-surface water for ballast water exchange and for engine cooling. Such vessel water withdrawals would also occur during decommissioning activities and during operation when any maintenance activities would be required. Construction vessels withdrawing surface water for ballast water exchange would be required to adhere to all U.S. Coast Guard (USCG) regulations and requirements for water withdrawal and discharge. This process of withdrawing water for ballast water exchange is commonly practiced and is no different than the processes practiced by other vessels already operating in the area. Water withdrawals associated with engine cooling occur for essentially all motor vessels, and this would be the case for construction vessels, tugs, crew boats, etc. For vessels underway, the water withdrawals occur along the transit route, and would include entrainment of small marine organisms, which typically occur in a patchy manner throughout the ocean. A certain percentage of these organisms would be injured or suffer mortality as a result of passage through pumps and heat exchangers, both from mechanical forces as well as possibly thermal increases.

The jet plow itself would require additional water withdrawals in order to operate. The intake for the jet plow is expected to be located off of one of the surface vessels and tethered to the jet plow. Water withdrawals for use in the jet plow embedment operation would be withdrawn from the near-surface area. Any early life stages of fish (eggs or larvae) that may be present in the immediate area of water withdrawal have the potential to be entrained during this process. Those eggs or larvae entrained during water withdrawal would likely suffer 100 percent mortality as the water is forcefully injected into the sediments to loosen and liquefy them. Millions of fish eggs and larvae may be present in the withdrawn water, depending on the season. However, given the fecundity of fish, the loss of eggs and larvae only represents a small fraction of equivalent adults of the species that are present. Given that commercial fishing vessels and ferries have traversed the Horseshoe Shoal area for years, impacts from the incremental increase from the jetting is short term and minor.

The species that could potentially be impacted by these water withdrawals include those with planktonic egg and/or larval stages at the time of jet plow operation. Early life stages that are benthic or demersal in nature are not expected to be impacted since water withdrawal would occur at or near the water surface. Table 2 summarizes the early pelagic life stages with designated EFH in the proposed action area that have the potential to be impacted by water withdrawals during certain months of the year. Since the jet plow process is expected to progress relatively rapidly, impacts are expected to be short-term and minimal in any one area. Impacts to these early pelagic life stages that have designated EFH in the proposed action's area would also be limited to those months (see Table 2) of the year where jet plow operation coincides with the occurrence of particular life stages in the area. The estimated impacts from cable jet plow entrainment to fish and invertebrate eggs and larvae are summarized in Table 5.3.2-6. The total number of fish eggs and larvae lost could be 48.5 million. Impacts of the jet plow water withdrawal on the five finfish with EFH for eggs or larvae in the area are expected to negligible to minor. This is in part due to the fact that very few eggs and larvae normally survive to adulthood. In one study of winter flounder Saila et al. (1999) estimated that only one in 2,700 larvae survive to adulthood in coastal New Hampshire waters.

Table 2.
Summary of Early Pelagic Life Stages of Fish Species with Designated EFH with Potential for Impact by Water Withdrawals during Certain Months of the Year

Species with early Pelagic Life Stages	EPH Life Stages in Proposed Action Area	Potential Time of Year Present in Nantucket Sound
Black seabass (*Centropristis striata*)	Larvae	August – September
Winter flounder (*Pseudopleuronectes americanus*)	Larvae	March – July
Summer flounder (*Paralichthys dentatus)*	Eggs, larvae	October – May
Atlantic butterfish (*Peprilus triacanthus*)	Eggs, larvae	April – August
Atlantic mackerel (*Scomber scombrus*)	Eggs, larvae	Unknown

5.2.4 Acoustical Impacts

5.2.4.1 INTRODUCTION TO UNDERWATER ACOUSTICS

Sound can be measured in many terms, including frequency and sound pressure. Frequency is the rate of the sound wave vibration and is measured in cycles per second or Hertz (Hz) (Richardson et al., 1995). For airborne and underwater sound pressure, the standard unit of measurement is the decibel (dB), a logarithmic scale formed by taking 20 times the $\log_{10}$ of a ratio of two pressures: the measured sound pressure divided by a reference sound pressure. Above air sound is referenced to 20 µPa (MicroPascals = 10^{-6} Newton/m^2), while underwater sound is referenced to 1 µPa. 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 the two media. Thus, the reader should not try to equate dB levels reported for water with those in air, or vice-versa.

A sound can also be transient or continuous. A transient sound (i.e., an explosion) has an obvious starting and stopping point while a continuous sound (e.g., offshore oil drill) is more or less persistent. The monopiles would be installed using pile driver technology and a pile driver is categorized as a repeating transient sound. Underwater construction sound is in the low frequency bands. Vessel underwater sound has its energy peak well below 1,000 Hz (Richardson et al., 1995), and pile driving sound is concentrated in the very low frequencies below 250 Hz.

The total background ambient sound in the open ocean is about 74 to 100 dB re 1 µPa. However, several natural sound sources, such as earthquakes, lightning strikes, and some biological sounds, such as vocalizations of baleen whales and some swimbladder sounds of fish, may temporarily increase natural ambient sound above these levels. Sound source levels for different types of natural noise in the marine environment are presented in Table 3. Source level is defined as the underwater sound pressure level that would be measured at a reference distance of 1 m (3.28 ft) from an ideal point source radiating the same amount of sound as the actual sound being measured. Source levels generally cannot be measured at 1 m because of the near-field effect. The actual sound pressure level experienced by a marine animal from a particular source depends on the source level and the distance the animal is from the sound source.

Table 3.
Maximum Broad-Band (20-1000 Hz) Sound Source Levels for Different Types of Natural Ambient Noise in the Marine Environment

Noise Source	Maximum Source Level (dB re 1 μPa @ 1 m)	Remarks
Undersea Earthquake	272	Magnitude 4.0 on Richter scale (energy integrated over 50-Hz band width)
Seafloor Volcanic Eruption	255+	Massive steam explosions
Lightning Strike on Water Surface	250	Random events during storm at sea
Baleen Whales	to 188	<2000 Hz simple and complex calls, clicks, pulses, knocks, grunts, moans
Swimbladder Sounds of Fish	140	Marked spectral peaks in 50-3000 Hz range
Dugong	<90	2000-5000 Hz simple chirps and squeaks

Sources: Richardson et al. (1995), McCauley (1994), and Advanced Research Projects Agency (1995).

Information on the hearing thresholds for finfish is summarized in Section 5.2.4.2 below. The potential risk of acoustic disturbance that could result in injury or disturbance to finfish is evaluated for sounds emitted during monopile construction, other construction, vessel transit, and operation in Sections 5.2.4.3 through 5.2.4.6 below. The complete noise analysis with respect to marine animals, including finfish is presented in Report No. 5.3.2-2.

5.2.4.2 HEARING THRESHOLDS FOR FISH

As described in Report No. 5.3.2-2, the hearing threshold is the minimum sound level in a 1/3-octave band that can be perceived by an animal in the absence of significant background noise. The hearing bandwidth for an animal is the range of frequencies over which an animal can perceive sound.

Finfish have a relatively narrow hearing bandwidth, in the range of 16 to 1,600 Hz, in which their hearing threshold is 80 to 130 dB re 1 μPa. Data from nine sources (Nedwell et al., 2004; Hastings and Popper, 2005) have been combined to produce maximum likelihood estimates of hearing thresholds, summarized in Table 5 of Report No. 5.3.2-2, for tautog, bass, cod, and Atlantic salmon.

5.2.4.3 MONOPILE CONSTRUCTION

The maximum submarine sound generated during offshore construction would occur during installation of the monopile foundations. Sound levels measured during impact pile driving operations at the Utgrunden Wind Park in Sweden were used to model underwater sound expected from installation of the monopiles since the size of the monopiles and the installation techniques proposed are the same as for the Utgrunden Wind Park (see Report No. 4.1.2-1). The Utgrunden data show a maximum (L_{max}) sound level of 178 dBL at 500 m (1,640 ft). Frequency plots from the Utgrunden data show the peak energy from pile driving occurred between 200 and 1,000 Hz, with underwater sound levels falling below background levels (inaudible) for frequencies below 5 Hz.

In order to determine the actual underwater sound level that is heard by finfish from monopile installation, a hearing threshold sound level (dB_{ht}) was calculated for three fish species for which data were available. The dB_{ht} for a given species is calculated following the method developed by Nedwell and Howell (2004) by passing the frequency spectrum of underwater sound produced by a source through a filter that mimics the frequency-dependent hearing thresholds of that species. The benefit of this approach is that it enables a single number to describe the effects of sound on that species, thereby allowing one to compare acoustic effects among species. The dB_{ht} represents the level of sound perceived by a certain species by taking into account its frequency-dependent hearing thresholds. For estimating the zone of injury for marine species, a sound pressure level of 130 dB_{ht} re 1 μPa (i.e., 130 dB above an animal's hearing threshold) is recommended (Nedwell and Howell, 2004; University of California, 2005).

Of the five groups of marine animals considered in the underwater sound analysis, toothed whales (dolphins, porpoises, pilot and minke whales) have the lowest hearing thresholds in the frequency range where construction sounds would occur. Those thresholds are around 50 dB re 1 µPa, and 130 dB above that hearing threshold level is a sound level of 180 dB re 1 µPa, which is the present NMFS guideline for preventing injury or harassment to all marine species (Kurkul, 2002). The 180 dB re 1 µPa sound level guideline is also highly protective to finfish since it is equal to 100 dBht re 1 µPa (180 minus the 80 dB minimum finfish hearing threshold) and is thus 30 dB below the 130 dB_{ht} re 1 µPa threshold for injury.

Note that since the NMFS 180 dB re 1 µPa guideline is designed to protect all marine species from high sound levels at any point in the frequency spectrum, it is a very conservative criterion. The dB_{ht} calculated for each combination of proposed action activity and marine species is a more accurate measure of acoustic effects than simply comparing the sound level to the NMFS 180 dB criterion because the dB_{ht} method takes into account the frequency distributions of both the sound source and the receiving animal's hearing thresholds.

Research shows significant marine animal avoidance reactions occur and mild behavioral reactions occur at 70 dB_{ht} re 1 µPa (Nedwell and Howell, 2004; Nedwell et al., 2004). Using the hearing threshold data from Table 5 in Report No. 5.3.2-2, dB_{ht} sound levels were calculated for finfish for the proposed action's loudest construction noise (pile driving) and the results are provided below in Table 4. Construction noise results are given for the NMFS safety radius of 1,640 ft (500 m) and two closer distances, 1,050 ft (320 m) and 98 ft (30 m), where source measurements were made at the Utgruden wind park (see Report No. 4.1.2-1). Pile driving sound levels cannot be reliably estimated for distances closer than 30 m (98 ft) due to near-field effects. The 1,640 ft (500 m) safety radius is based on a condition in the USACE Permit granted to the applicant for construction and operation of a SMDS [Permit No. 199902477]. The condition requires that sound level monitoring during pile driving procedures be conducted at an initial safety zone radius of 1,640 ft (500 m) to determine compliance with the 180-dBL NMFS threshold. A similar safety radius was established by NMFS for pile installation at the San Francisco-Oakland Bay Bridge (Illingworth & Rodkin, Inc. 2001; SRS Technologies, 2004)).

Table 4.
Predicted Underwater Sound Levels Perceived by Finfish (Hearing Threshold Sound Levels) from Construction

Finfish species	Perceived Sound of Pile Driving (Hearing Threshold Sound Levels - dB_{ht} re 1 µPa)		
	At 500 m (1640 ft)	At 320 m (1050 ft)	At 30 m (98 ft)
Tautog	81	85	105
Bass	76	80	100
Cod	87	91	111
Atlantic salmon	72	76	96

Note: Research shows marine animal avoidance reactions occur for 50 percent of individuals at 90 dB_{ht} re 1 µPa, occur for 80 percent of individuals at 98 dB_{ht} re 1 µPa, and occur for the single most sensitive individual at 70 dB_{ht} re 1 µPa. For estimating the zone of injury for marine animals, a sound pressure level of 130 dB_{ht} re 1 µPa (i.e., 130 dB above an animal's hearing threshold) is recommended.

The results of this dB_{ht} analysis (see Report No. 5.3.2-2 for full analysis) show that no injury to finfish are predicted even if an individual were to approach as close as 30 m (98 ft) to the pile driving because all dB_{ht} values at this minimum distance are well below 130 dB re 1 µPa. Therefore, underwater construction sounds are not expected to cause physical harm to finfish.

The dB_{ht} data presented in Table 4 were then used to calculate the zone of behavioral response for pile driving at the proposed action site. These results, summarized in Table 5, give the distance from the monopile where a significant avoidance reaction would occur for each species, i.e., where dB_{ht} = 90 dB re 1 μPa. Avoidance by a minority of individuals would be expected at lower levels and hence at slightly greater distances than those listed in Table 5.

If finfish are in the proposed action construction area, they are likely to temporarily avoid the zone of behavioral response around the monopile being driven a protective reaction). Table 5 reveals that behavioral effects (avoidance) would occur at a range of 60 to 350 m (197 to 1,148 ft) by finfish.

Table 5.
Calculated Zone of Behavioral Response for Significant Avoidance Reaction to Pile Driving

Finfish	Distance Where dB_{ht} = 90 dB re 1 μPa and Avoidance Reaction May Occur (m)
Tautog	180
Bass	100
Cod	350
Atlantic salmon	60

Any impacts to fish within 1,640 ft (500 m) would be minimized by using a “soft start” of the pile driving equipment (use of a low energy start) to allow fish to move away from the area in response to construction sound. Furthermore, use of “soft start” pile driving techniques is expected to help clear finfish to a safe distance from the immediate construction zone before maximum pile driving sounds are reached. Avoidance effects are temporary, limited to a relatively small area around the one monopole being driven at any one time, and avoidance effects disappear only hours after pile driving ceases. Only two pieces of pile driving equipment would be present at any one time, and they are unlikely to be operating simultaneously. Thus, negligible impacts on reproduction or survival for marine finfish are expected from construction. For additional details on construction please see Section 2.3 of this final EIS.

As an added protection measure, underwater sound monitoring would be performed during initial monopile construction (the first three monopiles - as was done to ensure protection of marine mammals during the installation of the SMDS foundation piles). Underwater sound pressure level measurements would be made at an Initial Safety Zone radius of 500 m to determine compliance with the 180 dB NMFS threshold. Hydrophone measurements would use the Lmax RMS “fast” setting, and data would be analyzed on a real-time basis to ensure continuing compliance. The SMDS permit stipulated that if measured levels exceeded the threshold, a site-specific Safety Zone radius corresponding to the 180dB threshold would be established and the NMFS approved observer would be advised of the expanded action area for observation of marine mammals. Similar measures would be followed for the installation of the monopiles. These measures would also have benefits to any finfish species in the proposed action vicinity. During installation of the SMDS, measured sound levels did not exceed the 180dB threshold at or beyond the initial Safety Zone radius.

Acoustical impacts to fish eggs and larvae from monopile installation have not been well studied. While it is possible that the sound produced during monopile driving could have a negative effect on fish eggs and larvae in the immediate vicinity of the pile driving, there are no peer-reviewed studies of pile driving sound that establish the level of such effects. In a recent summary of research on fish eggs and larvae, Hastings and Popper (2005) conclude that “the few studies on the effects of sound on eggs, larvae, and fry are insufficient to reach any conclusions with respect to the way sound would affect survival. Moreover, most of the studies were done with seismic air guns or mechanical shock, which are stimuli that are very different than those produced by pile driving.”

Effects of pile driving noise on marine invertebrates are expected to be negligible. An evaluation of the BATHOLITHS airgun seismic surveys off the coast of British Columbia predicted only minor, short-term, sub-local and insignificant impacts on invertebrates (LGL Ltd. and JASCO Research Ltd., 2006). It should be noted that airguns produce some of the loudest peak human-made underwater noises (NMFS) and are designed to penetrate to great depths; therefore predicted impacts to invertebrates from local monopile driving are expected to be much less than that anticipated from the BATHOLITHS program.

5.2.4.4 OTHER CONSTRUCTION SOUNDS

The jet plow embedment process for laying the two submarine transmission cable circuits and inner-array cables produces no sound beyond that produced by typical vessel traffic and the cable installation barge would produce sound typical of vessel traffic already occurring in Nantucket Sound. No substantial underwater sound would be generated during HDD operations used to transition the submarine transmission cable to the onshore transmission cable system in Lewis Bay. Due to the sound-insulating qualities of earthen materials (the sediment), and the fact that the drilling would take place through unconsolidated material, the HDD transition is not anticipated to transmit vibration from the sediment to the water (i.e., it would not add appreciable sound into the water column). The installation of sheet steel for the cofferdam would utilize a low-noise vibratory method and would not use impact pile driving. As a result, the main underwater acoustical impacts during construction activities would be limited to that generated by installation of the monopile foundations and vessel traffic.

5.2.4.5 VESSEL SOUNDS

Fish typically show a variety of avoidance behaviors when a noise-emitting vessel is detected. Different types of fish respond in different ways to noise originating from ocean vessels: pelagic species tend to dive deeper in the water column, while demersal species make lateral movements. Most fish species, whether pelagic or demersal, have been observed to increase their swimming speed when vessel noise is detected.

Construction would result in increased vessel traffic between the WTG array site, the submarine transmission cable system route, and Quonset, RI (where construction laydown is planned to occur). The sound source level for a tug and barge traveling at low speed, the typical construction vessels for the proposed action is 162 dB re 1 μPa @ 1 m (3.3 ft) (Malme et al., 1989). Using the reported sound source level for tugs and barges, the maximum perceived underwater sound level was evaluated at 10 ft (3 m) for finfish using the hearing-threshold data presented in Table 5 in Report No. 5.3.2-2. The maximum hearing-threshold sound level (dB_{ht} re 1 μPa) for finfish at a distance of 10 ft (3 m) from a vessel was calculated as 73 dBht re 1 μPa. Finfish would be able to hear the vessel but the sound levels are safely below the 130 dB_{ht} re 1 μPa threshold for preventing injury or harassment. Therefore, vessels that are 10 ft (3 m) or greater from finfish should not cause physical harm. The 73 dBht re 1 μPa sound level at 10 ft (3 m) is above the 70 dBht re 1 μPa threshold for avoidance by the most sensitive finfish individual, and thus finfish in the vicinity may display avoidance behaviors to vessels. These behaviors, however, would be short-term and would likely be similar to the behaviors observed during activities that regularly occur in Nantucket Sound such as pleasure boat use, ferry traffic, and fishing. Decommissioning-related impacts would be short-term and localized and are expected to be similar to or less than impacts during construction. Vessel traffic generated by proposed action activities is not expected to have a significant effect on the early life stages of fish species, as it would be typical of vessel traffic already occurring in Nantucket Sound.

5.2.4.6 OPERATIONAL SOUND

Once installed, the operation of the WTGs is not expected to generate substantial sound levels above baseline sound in the area. Acoustic modeling of underwater operational sound at the offshore proposed action area was performed for the design wind condition (see Section 4.1.2.3 of this final EIS). Baseline underwater sound levels under the design wind condition are 107.2 dB re 1 µPa (see Section 4.1.2.3 of this final EIS). The predicted sound level from operation of a WTG is 109.1 dB re 1 µPa at 20 m (65.6 ft) from the monopile (i.e., only 1.9 dB re 1 µPa above the baseline sound level), and this total sound level falls off to 107.5 dB re 1 µPa at 50 m (164 ft) and declines to the baseline level at a relatively short distance of 110 m (361 ft). Since the WTGs would be spaced farther apart than 110 m (361 ft) (approximately 629 to 1,000 m or 0.34 to 0.54 nautical miles [NM] apart), cumulative impacts from the operation of the 130 WTGs are not anticipated.

In order to determine the actual underwater sound level that is heard by finfish during operation, a dB_{ht} was calculated. Using the hearing threshold data from Table 5 in Report No. 5.3.2-2, dB_{ht} sound levels were calculated for proposed action operation. Operation sound results are given for the two distances where source measurements were made in the Utgruden and Gotland wind parks, 20 m (65.6 ft) and 100 m (328 ft) (see Report 4.1.2-1). Operation sound levels cannot be reliably estimated for distances closer than 20 m (65.6 ft) due to near-field effects._ The results indicate that at 100m (328 ft) and 20 m (65.6 ft), perceived operational sound levels for finfish were 7 dB_{ht} re 1 µPa and 21 dB_{ht} re 1 µPa, respectively. Since operational sound would be only barely audible to finfish at the extremely close distance of 20 m (65.6 ft), it is also unlikely to have any adverse effect on fish eggs or larvae.

The results of this dB_{ht} analysis (see Report No. 5.3.2-2 for full analysis) show that no injury or behavioral effects to EFH finfish species are predicted even if an individual were to approach as close as 20 m (66 ft) to a monopile when the proposed action is operating at the design wind speed because all dB_{ht} values at this minimum distance are well below 130 and 90 dB re 1 µPa. Operational sounds would only be slightly audible to finfish at the extremely close distance of 20 m (66 ft). Research conducted at offshore wind farms in Europe suggest that the very low vibration from wind turbines does not impact fishes in the region (AMEC, 2002). At the Näsrevet Windfarm in Sweden, Westerberg (1999) reported that the normal operational sounds of a wind farm did not greatly impact the migration of eels.

Based on the dB_{ht} analysis and observations from offshore wind farms in Europe (Vella, 2002; Westerberg, 1999), underwater sound levels from the WTGs for the proposed action are not anticipated to cause physical harm or behavioral changes to finfish, including those with designated EFH in the area.

5.3 Reef Effect

Research on the potential effect of the monopile foundations on fish species, including those with designated EFH in the area, was conducted. This research included in-depth discussion of possible fish aggregation, reef effects, and spacing considerations for the monopiles.

The vertical structure that would be created from the installation of wind turbine towers is not anticipated to result in adverse impacts to the ecology of the immediate proposed action area or to Nantucket Sound. Although the walls of the towers represent a source of new hard substrate with a vertical orientation in an area that has a limited amount of such habitat, this new substrate is not favorable for colonization or reef formation due to its low complexity and rugosity (the steel material used has much lower surface roughness than comparable wood or cement structures) (CARPG, 1998).

Despite the anticipated utilization of the monopile structures by certain fouling and hard-bottom benthic organisms (see Section 5.1.5.11 of this final EIS), the individual monopiles are not expected to serve as true artificial reef structures that would serve to significantly alter the benthic or finfish communities within Nantucket Sound. Historical and recent research conducted on the design of artificial reefs indicates that the major design features that affect the function of artificial reefs are complexity and rugosity (the material used and roughness), as well as surface area, profile, shape, orientation and size

(CARPG, 1998). The quantity and nature of interstitial spaces in reef structures are important in determining the degree and complexity of the biological community developing on and around the reef. Adequate interstitial spaces are necessary to establish a rich diversity of motile invertebrates as well as numerous cryptic fish species (CARPG, 1998). The monopiles would not have any interstitial space and given the wide spacing between the individual monopiles (0.34 to 0.54 NM (629 to 1,000 m) apart), there would not be creation of interstitial space among the monopiles collectively at a scale that would be beneficial to benthic organisms or most fish.

The proposed monopile structures would provide a high profile but cylindrical structure of poor complexity and low rugosity. Thus, fish attraction to the monopile structures is not expected to be as marked as that for planned artificial reefs or complex steel structures such as oil and gas platforms (Wilson et al., 2003) which have a high profile, open latticework structure. Certain demersal EFH species in Nantucket Sound that show territorial or reef-obligate life histories may be attracted to the monopiles including, but not limited to: Atlantic cod, black sea bass, and scup. In addition, it should be noted that the distance between the monopile structures is within the sensory range for flatfish. Flatfish such as flounder, sole and dab have been shown to be attracted to submarine structures at distances of 1,969 ft (600 m) and flounder have been shown to move between 2 reef structures at a distance of 2,953 ft (900 m) (Grove et al., 1989). Because of their relatively high mobility between underwater structures, these species may become more vulnerable to fisheries, increasing the exploitable biomass. In addition, flatfish species have been found to be attracted to artificial reefs (Polovina and Sakai, 1989), although it is believed that they visit the reefs primarily to forage.

In general, it is not likely that the addition of new hardened structures in Nantucket Sound would introduce species that aren't currently there, because artificial hard substrate can already be found throughout the harbor and port areas within the Sound in the form of pilings associated with wharfs and breakwaters. Some studies have shown that artificial reefs simply redistribute the resources without increasing the biomass (Polovina & Sakai, 1989). A recent conference on reef biology in New Zealand concluded that "The common assumption that artificial reefs provide habitat for organisms that would not have otherwise settled and survived (i.e., that marine populations are habitat-limited) should be treated with caution" (Burgess et al., 2003). A conclusion more specific to wind parks may be drawn from research done in support of the Horns Rev Offshore Wind Farm (Horns Rev) windmill park in Denmark. A study was conducted to describe the possible artificial reef impact on fish of the monopile foundations of the planned marine windmills (DIFR, 2000). The Horns Rev project is on a smaller scale than the proposed action, being only 80 units forming an 8 x 10 grid, 1,804 ft (550 m) apart. However the two projects are similar enough to draw conclusions on potential reef effect impacts. The Horns Rev project concluded that "Considering the hydrography and material and design of the Horns Rev structures, there is no indication that the windmill foundations would provide a significant food-chain basis" even though monopiles at the Horn's Rev wind farm were found to be colonized by bryozoans, sea anemone, sea squirts, starfish and the common mussels (*Mytilus edulis*) within 5 months of its construction (S.E Ltd., 2002). Based on the design similarities of the proposed action and the Horns Rev project, it would be reasonable to conclude that the proposed action, a comparable project, would not have significant impact on the food-chain or the ecology of Nantucket Sound.

It is also improbable that increasing the wide spacing of the monopiles would increase the area of change and spread the effect over a greater area. If each monopile is viewed as a separate reef structure to itself, then discoveries pertaining to the optimal design of artificial reef structures may help describe the likely effect. Researchers at the University of Florida tested effects of different reef designs and spacing patterns on artificial reef populations and found that design and spacing are important (reefs too close together or too far apart are not as effective (Alessi, 1996). An investigation into varying reef dispersion to manage targeted fishery assemblages found approximately the same number of fish species attracted to clumped reefs and dispersed reefs, though the number of fish attracted to the clumped reefs was always higher (Lindberg et al., 1989-1990). The study conclusion recommended that fishery managers should consider clumped reefs as a method to enhance overall fish abundance (Lindberg et al., 1989-1990). Another investigation into how patch reef isolation affects fish assemblage structure (Jordan et al., 2005) also found no significant differences in fish abundance and richness between the most closely spaced and furthest spaced reef configurations. Based on these research efforts and the fact that the proposed action would have widely-spaced monopiles, it is likely that the proposed action would have little or no significant impact to the finfish resources due to the introduced vertical structure.

In addition, several isolated rocks and areas of coarse glacial till do exist in shoal areas throughout Nantucket Sound, and are likely to support benthic communities similar to those that may become established on the WTGs. Although the monopile foundations would create additional attachment sites for benthic organisms that require fixed (non-sand) substrates, the additional amount of surface area being introduced (approximately 1,200 ft^2 (0.03 acre or 111 m^2)) per tower, assuming an average water depth of 30 ft (9.1 m)) would be a minor addition to the hard substrate that is already present. Therefore, it is likely that these isolated structures would generate a relatively small amount of additional patch reef type habitat, common in the Sound, further supporting the conclusion that the monopiles would not substantially alter the fish community or ecology of Nantucket Sound. Other types of similar artificial hard substrate can be found throughout harbor and port areas within the Sound that have pilings associated with wharfs and breakwaters constructed over the decades for the protection of anchorages and harbors.

Removal of the monopiles would eliminate the vertical structure-oriented habitat offered by the monopiles that some species prefer and may cause these species to disperse elsewhere. If any of these fish species were subject to increased fishing pressure during the life of the proposed action, removal of the monopiles may allow subsequent dispersal of the aggregated fish, thereby reducing fishing pressure on these species in the area.

5.4 Underwater Electromagnetic Field (EMF)

Potential impacts to fish species, including those with designated EFH in the proposed action area, from electromagnetic/thermal emissions during the normal operation of the inner-array cables and the two submarine transmission cable circuits are expected to be negligible. The cable system (for both the inner-array cables and each of the transmission cable circuits) is a three-core solid dielectric AC cable design, which was specifically chosen for its minimization of environmental impacts and its reduction of any EMF. The proposed inner-array and submarine transmission cable systems would contain grounded metallic shielding that effectively blocks any electric field generated by voltages on the conductors within the cable systems. Since the electric field would be completely contained within those shields, impacts are limited to those related to the magnetic field emitted from the submarine transmission cable and inner-array cables. As described in Report No. 5.3.2-3, the magnetic fields associated with the operation of the inner-array cables or the submarine transmission cable system are not anticipated to result in an adverse impact to marine organisms, including EFH species and their prey.

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

Because the inner-array cables and the two submarine transmission cable circuits connecting the WTGs to the landfall would be buried approximately 6 ft (1.8 m) below the seabed, they would not pose a physical barrier to fish passage. The considerable depth to which the cables would be buried would allow benthic organisms to colonize and demersal fish species (including demersal eggs and larvae) to utilize surface sediments without being affected by the cable operation. The burial depth of the cables also minimizes potential thermal impacts from operation of these cable systems. In addition, these cable systems utilize solid dielectric AC cable designed for use in the marine environment that does not require pressurized dielectric fluid circulation for insulating or cooling purposes. Early or older life stages of finfish and essential fish habitat would not be directly impacted during the normal operation of the inner-array or submarine transmission cable systems. There would also be no impacts to invertebrate or plankton prey species of fish (indirect impact) during the normal operation of the inner-array or submarine transmission cable systems.

5.5 Rotor Shadow Effect

As fish swim into the area affected by rotor shadow, they are unlikely to be startled because they would be able to see the periodic motion of the shadows ahead of time. Furthermore, shadows cast by wind turbine blades are unlikely to be perceived by fish as rapidly growing shapes, which is the primary cause of their startling (Webb, 1982) since this does occur with avian predation. Rather, the shadow shape should remain fairly constant at any given point in the water, even as the blades spin. When the blades are not spinning, the shadow would be relatively static. As the blades spin faster, the shadows of each individual rotor blade would become less distinct and harder to perceive. Additionally, the speed of the rotor shadow, as perceived by finfish, would remain fairly constant over short periods of time. This should preclude a sense of shadow acceleration (the looming threshold), as might be expected with avian predation from above (Paglianti and Domenici, 2006). As such, the number of energy-intensive predator evasion responses due to rotor shadow movement is expected to be minimal.

In addition, the fact that water is denser than air causes light to be refracted toward the water surface. Because the surface of marine water is inevitably wavy, this leads to a dappling effect of light and dark through the water column and on the seafloor. Marine fishes are accustomed to these shifting patterns of light from above—in fact, many fish species (e.g., whale shark and lanternfish) have developed camouflage that mimics these patterns (Harcourt and Stanley, 2007; Shedd, Aquarium 2007). Therefore, the relatively thin, shifting shadows cast by wind turbine rotors are not expected to significantly contribute to a sense of top-water predation.

5.6 Water Flow, Currents, Waves, Sediment Transport

In order to determine the potential zone of influence of the WTG piles, evaluation studies were performed using the HYDROMAP model to calculate currents and a series of analyses to assess the zone of influence of the WTG pile array based on its effects on waves and currents. The full analysis is included as Report No. 4.1.1-4.

Based on the WTG pile diameter and wave lengths in the area, the piles are essentially invisible to the waves. Therefore, the presence of the WTGs would not affect wave conditions in the area. The zone of influence of the WTG pile on wave and current conditions are estimated to be limited to an area of 5 pile diameters long (87 ft (27 m)) by 2 piles diameters wide (35 ft (11 m)) at most. The total area for all 130 piles, less than 9 acres (0.0364 km^2) can be compared to the total area of the wind farm of 15,800 acres (64 km^2), thus 0.057 percent of the area of the wind farm is potentially affected. A small portion of this area would be affected since the effects dissipate rapidly away from the WTG pile. The large spacing between the WTGs and the small WTG pile diameter is expected to prevent the effects of each WTG pile on wave and current conditions from affecting adjacent piles. Therefore, the WTGs are not expected to affect wave and current conditions as a pile group.

The modeling analysis concluded that the presence of the WTGs should not affect wave conditions and would only have a limited localized effect on wave and current conditions. Large-scale changes to water flow and sediment transport over Horseshoe Shoal is not anticipated to result from the proposed action. Therefore, EFH species occurrence, abundance, and community structure are not expected to be affected by the minor changes to water flow and sediment transport over Horseshoe Shoal from the proposed action.

5.7 Impacts of Spills and Accidental Releases of Potential Contaminants

The WTGs have been carefully configured to contain any fluid leakage and prevent overboard discharges. Well-maintained equipment and training of personnel should prevent any spills from occurring. However, in the case of a spill, all service vessels would be equipped with spill handling materials to minimize and mitigate any impacts. In addition, waste collection systems would be installed on board each WTG. The waste collection system is based on a container system for easy and safe handling during transfer to and from towers, service vessels, and docks. Containers would be hoisted into and out of service vessels by a maintenance crane mounted on the WTG tower. The waste would be separated for proper disposal once the containers are off-loaded at the dock.

The ESP would have sealed, leak-proof decks around the transformers and other equipment where oil and/or other lubricants exist, which would serve as fluid containment. In addition, spill containment kits would be available near all equipment. Furthermore, the applicant would develop a Spill Prevention Control and Countermeasure (SPCC) plan in accordance with MMS regulations.

Oil would be stored in greater quantities than any other potential contaminant. To address this, a comprehensive Oil Spill Response Plan (OSRP) is under development. The OSRP is likely to provide finfish with a level of protection that is equal to or greater than marine mammals or sea turtles. This follows from the fact that, in the unlikely case of an oil spill, finfish are generally less likely than marine mammals and sea turtles to surface and come into direct contact with the spill. Unlike marine mammals and sea turtles, finfish do not surface in order to breathe and many marine finfish species never surface during the free-swimming stages of their life history.

In general, stocks are more likely to be at risk from an oil spill if the spill:

1. Occurs during spawning periods
2. Enters spawning grounds of species with restricted spawning areas (IPIECA, 2007)

The areal extent of an oil spill associated with the wind turbines or maintenance vessels would be so small that a significant ecological impact would be unlikely. The only significant source of oil is associated with the ESP as described in the OSRP and Report No. 4.1.3-1 and Report No. 5.2.1-1. Impacts to fish spawning may be addressed by referencing Table 1 in Section 4.0 of this EFH Assessment document, which shows that EFH for spawning is only designated for two federally managed species within the proposed action area, and that both of these species (winter flounder and windowpane) are wide-ranging demersal spawners with long spawning periods (NOAA, 1999a/b). Therefore, it is anticipated that stocks of these species are at low risk from an oil spill.

If an oil spill were to occur within the proposed action area, including a mineral oil spill from the ESP, juvenile and adult finfish would be likely to avoid the area directly affected by oil spills, thereby minimizing direct mortality from contact with oil. Some commercial finfish species have floating egg and larval life stages, which are more susceptible to injury or mortality from oil spills than the free-swimming juvenile and adult stages. However, these species also typically spawn over large areas and produce hundreds of thousands to millions of eggs per fish each season. Therefore, a small oil spill from the turbines, maintenance vessels or the ESP in Nantucket Sound would be unlikely to have a significant impact on recruitment from early life stages. Finfish with demersal eggs and larvae are even less likely to be affected by oil spills.

Another concern is that the homing ability of anadromous finfishes (e.g., river herring) might be impaired by an oil spill occurring during migration from the sea to fresh water. However, the degree of impact is uncertain—for instance, no such impairment was detected by Nakatani and Nevissi (1991) for Coho salmon.

5.8 Species Specific Impacts

Potential impacts discussed in Sections 5.1 through 5.7 above that may affect the benthic and pelagic fish and invertebrate species with designated EFH in the proposed action area are summarized in Appendix B, Tables B-1 through B-3. In order to assess impacts more efficiently, target species were grouped into four categories: early life stages (eggs and larvae) of benthic-oriented species (Appendix B, Table B-1), early life stages of pelagic-oriented species (Appendix B, Table B-1), older life stages (juveniles and adults) of benthic-oriented species (Appendix B, Table B-2) and older life stages of pelagic-oriented species (Appendix B, Table B-2). Since potential impacts to all species is highly dependent on the time of year that activities occur, Appendix B, Tables B-1 and B-2 also describe the potential season(s) when these life stages may be present in Nantucket Sound. Potential impacts to species with designated EFH in the proposed action area are summarized by the four categories described above in Appendix B, Table B-3. This table describes the level of impact to each category using the MMS definitions of impact levels and provides a brief description of the potential impact. This table serves to address impacts to the fish and invertebrate species with designated EFH by categorizing them into four groups for comparison. As can be seen in Appendix B, Table B-3, all impacts are projected to be minor or negligible.

5.9 Commercial Fishing

During proposed action development, several potential concerns were identified that relate to the commercial fishing industry. These concerns included potential restriction on fishing activities, potential construction impacts, and potential gear conflict due to presence of the cable systems or WTGs. During construction and decommissioning, the proposed action would not place restrictions on commercial or recreational fishing activity or create fishing exclusion zones in the proposed action locale. For protection of public safety there may be limited temporary vessel restrictions in proximity to construction sites and vessels, but these would not involve large enough areas or be in place long enough to reduce fishing opportunities. The only exception to this is the placement of fixed gear in the immediate area where WTGs, the ESP, or the cables are scheduled to be installed. The applicant would need to coordinate with lobstermen to make sure that lobster gear is not placed along a section of the cable routes that is going to be installed (or removed during decommissioning), since gear damage or loss would occur from the jetting equipment. Once installed, lobstermen would be able to resume placing gear within the cable routes. Similarly a short term exclusion of fixed gear would be required around a WTG to prevent damage or loss due to jack up barge operations. Once a WTG is completely installed, fixed gear could be placed in proximity to it, at the fisherman's discretion, and in a manner that does not affect maintenance vessel access. More discussion of potential impacts on commercial fisheries is provided in Section 5.3.2.7 of the DEIS. Commercial fishing activities may be subject to temporary disruption in close proximity to construction activities. Potential impacts of construction activities are expected to be minor with regard to commercial fishing activities and commercial fishing gear. Impact minimization measures that the applicant has already incorporated into development of the proposed action, includes the relocation of several WTGs away from popular commercial fishing areas, and burying the inner-array cables and two submarine transmission cable circuits to a minimum of 6 ft (1.8 m) below the seabed to avoid the potential for conflicts with fishing vessels and gear operation. More discussion of mitigation is provided in Section 9.0 of the DEIS.

6.0 MITIGATION

General

The NOAA Fisheries comment letter on the ACOE draft EIS/R suggested that the applicant provide compensatory mitigation for temporary and permanent impacts on EFH commensurate with the anticipated level of impact. The applicant has committed to providing $4.22 million in funds for compensatory mitigation to the State of Massachusetts. The State plans to use this plus the additional $5.78 million derived from the Federal lease payment over the life of the project to monitor and mitigate project impacts.

Mitigation measures described here include selected construction methods, measures for protection of eelgrass, and time-of-year in-water restrictions related to sensitive fish species. Also, additional discussion of mitigation is provided in Section 9.0 of the DEIS.

Construction Methods

As discussed previously in Section 5.2.1, the pile driving hammer and jet plow technology that would be used to install the monopile foundations and the submarine cables, respectively, were selected specifically for their ability to keep sediment disturbance to a minimum.

Eelgrass

MMS would require the following conditions to minimize and mitigate, if necessary, potential impacts to eelgrass:

- No anchoring of vessels or performing cable installation work in the area near Egg Island where eelgrass beds are located.
- Conducting a dive survey to confirm the limits of the eelgrass bed near Egg Island (verifying the limits of SAV previously surveyed in July 2003) prior to the commencement of cable installation in the same calendar year preceding construction.
- Using divers to confirm correct placement of work vessel anchors.
- Replanting eelgrass, if during installation of the submarine transmission cable, the eelgrass beds are disturbed.
- Performing pre- and post-construction monitoring of the eelgrass bed and, if it is determined that eelgrass has been lost, conducting replanting. The post-construction monitoring plan would be developed to document potential indirect impacts from cable embedment and subsequent habitat recovery. Habitat recovery would be considered successful if it is found that SAV has migrated back to the site of disturbance. Should the habitat not recover naturally, the disturbance would be mitigated by replanting.
- Conducting aerial photography of the entrance to Lewis Bay in the month of July immediately prior to jet-plowing, under conditions conducive to documenting the extent of eelgrass beds. These photographs would be used in finalizing the exact location of jet-plowing.

The applicant has also committed to the following additional items to minimize and mitigate, if necessary, potential impacts to eelgrass:

- As requested in the MEPA Certificate, the applicant would denote the edge of the eelgrass bed at the water surface with buoys near Egg Island. In addition, the applicant would implement a No Wake Zone for its construction vessels at a distance of 200 ft (61 m) from the edge of the eelgrass bed.
- An eelgrass survey would be performed for two consecutive years following construction to document the change in density.
- The scope of work to perform the dive survey at the eelgrass bed within Lewis Bay would be coordinated with the appropriate state and federal agencies.
- Develop a Before Action Control Impact (BACI) Plan.

Benthic Monitoring

Cape Wind Associates, as a condition of its Massachusetts State Water Certificate (WQC) issued on August 15, 2008, would be required to monitor the seabed habitat and benthic community, both pre- and post-construction. Post-construction would be conducted at one and two years after cable installation. Monitoring in year three would be an option if recovery was not occurring as expected. There is also an option for a fourth year of monitoring if the third year suggests progress in recovery such that recovery could be expected after another year. The plan also requires mitigation (to be determined) if recovery has not occurred by the third or fourth year.

Winter Flounder EFH Protection in Lewis Bay

To protect sensitive fish species such as winter flounder, the applicant has committed to avoid in-water construction in Lewis Bay between January 1 and May 31 of any year. No jet plow installation would occur during this timeframe. Therefore, the proposed action should not adversely affect winter flounder EFH, spawning winter flounder, or early life stages (eggs and larvae) of winter flounder in Lewis Bay. The applicant has requested that they be allowed to install the temporary cofferdam (drive sheet piling, install silt curtain and dredge the cofferdam pit) during the month of May. It is anticipated that most of the sediments would be contained by the silt curtain and sheet piles, thus avoiding impacts to winter flounder related to sediment transport and redeposition.

7.0 BIBLIOGRAPHY

7.1 Report References Cited

Report No. EFH-1. ESS Group, Inc. (ESS). 2006. Essential Fish Habitat Assessment for the Cape Wind Energy Project. ESS Project No. E259. Prepared for Cape Wind Associates, L.L.C., Boston, Mass. Wellesley, Mass., November 2006.

7.2 Literature Cited

Able, K. W., and M. P. Fahay. 1998. *The first year in the life of estuarine fishes in the Middle Atlantic Bight.* New Jersey: Rutgers University Press.

Able, K. W., M. P. Fahay and G. R. Shepherd. 1995. Early life history of black sea bass, *Centropristis striata*, in the Mid-Atlantic Bight and New Jersey estuary. *Fish. Bull* 93:429-445.

Able, K. W., R. E. Matheson, W. W. Morse, M. P. Fahay and G. Shepherd. 1990. Patterns of summer flounder, *Paralichthys dentatus*, early life history in the Mid-Atlantic Bight and New Jersey estuaries. *Fish. Bull* 88:1-12.

Advanced Research Projects Agency. 1995. Final environmental impact statement/ environmental impact report for the California acoustic thermometry of ocean climate project and its associated marine mammal research program. Advanced Research Projects Agency, Arlington, Va.

Alessi. M. 1996. "Private Reef Building in Alabama and Florida," http://www.cei.org/gencon/030,04421.cfm. Accessed July 2005.

Algonquin Gas Transmission Company. 2000. USACE Section 404/10 permit application for the HubLine Pipeline Project. November 30, 2000.

Allen, D. M., J. P. Clymer, III and S. S. Herman. 1978. Fishes of Hereford Inlet estuary, southern New Jersey. Lehigh Univ., Dept. Biol. and Cent. Mar. Environ. Stud. and the Wetlands Institute.

AMEC. 2002. "Lynn offshore wind farm environmental impact statement non-technical summary," http://www.amec.com/uploadfiles/LynnNTS.pdf

Bigelow, H. B. and W. C. Schroeder. 1953. Fishes of the Gulf of Maine. U.S. Fish Wildl. Serv. *Fish. Bull* 53.

Black, G. A. P., T. W. Rowell and E. G. Dawe. 1987. Atlas of the biology and distribution of the squids *Illex illecebrosus* and *Loligo pealei* in the northwest Atlantic. *Can. Spec. Pub. Fish. Aquat. Sci* 100.

Boschung, H. T., J. D. Williams, D. W. Gotshall, D. K. Caldwell and M. C. Caldwell. 1997. *National Audubon Society field guide to North American fishes, whales,* and *dolphins*. New York: Chanticleer Press, Inc.

Bowman, R. E., C. E. Stillwell, W. L. Michaels and M. D. Grosslein. 2000. "Essential Fish Habitat Source Document: Food of Northwest Atlantic fishes and two common species of squid." NOAA Tech. Memo. NMFS-F/NE-155. http://www.nefsc.noaa.gov/nefsc/publications/tm/tm155/tm155.pdf

Brodziak, J.K.T. and W.K. Macy, III. 1996. Growth of long-finned squid, *Loligo pealei*, in the northwest Atlantic. *Fish. Bull.* (U.S.) 94(2):212-236.

Buck, E. H. 1995. "Atlantic bluefin tuna: International management of a shared resource." CRS Report for Congress. 95-367 ENR. http://www.ncseonline.org/nle/crsreports/marine/mar-5.cfm Accessed September 2006.

Buckley, J. 1989. Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (North Atlantic) – winter flounder. U.S. Fish Wildl. Serv. Biol. Rep. 82(11.87). U.S. Army Corps of Engineers, TR EL-82-4.

Bumpus, D. F., R. E. Lynde and D. M. Shaw. 1973. "Physical Oceanography." In Coastal and offshore environmental inventory: Cape Hatteras to Nantucket Shoals. Marine Publication Series No. 2. Univ. of Rhode Island, Kingston, R.I.

Bumpus, D. F., W. R. Wright and R. F. Vaccaro. 1971. Sewage disposal in Falmouth, Massachusetts: Predicted effect of the proposed outfall. *J. Boston Soc. Civ. Engin* 58:255-277.

Burgess, S. C., K. P. Black, S. T. Mead and M.J. Kingsford. 2003. "Considerations for Artificial Surfing Reefs as Habitat for Marine Organisms," In 3rd International Surfing Reef Symposium, Conference Proceedings, Raglan, New Zealand, June 23-25, 2003, edited by K. Black and S. Mead, 289-302. Hamilton, New Zealand: ASR Limited. http://www.asrltd.co.nz/downloads/Reefs/3rd%20Surfing%20Reef%20Conference%20Papers/ASRs%20as%20Habitat%20for%20Marine%20Organisms.pdf

Burke, J. S. 1991. Influence of abiotic factors and feeding on habitat selection of summer and southern flounder during colonization of nursery grounds. Ph.D. Dissertation, North Carolina State Univ., Raleigh, N.C.

Burke, J. S., J. M. Miller and D. E. Hoss. 1991. Immigration and settlement pattern of *Paralichthys dentatus* and *P. lethostigma* in an estuarine nursery ground, North Carolina, USA. *Neth. J. Sea Res* 27:393-405.

Byrnes, M. R., R. M. Hammer, S. W. Kelley, J. L. Baker, D. B. Snyder, T. D. Thibaut, S. A. Zichichi, L. M. Lagera, S. T. Viada, B. A. Vittor, J. S. Ramsey and J. D. Germano. 2004. Environmental surveys of potential borrow areas offshore northern New Jersey and southern New York and the environmental implications of sand removal for coastal and beach restoration. U.S. Department of the Interior, Minerals Management Service, Leasing Division, Marine Minerals Branch, Herndon, Va. OCS Report MMS 2004-044, volume 1 and vol. 2.

Cargnelli, L. M., S. J. Griesbach and C. A. Zetlin. 1999a. Essential Fish Habitat Source Document: Northern shortfin squid, *Illex illecebrosus*, life history and habitat characteristics. NOAA Tech. Mem. NMFS-NE-147.

Cargnelli, L. M., S. J. Griesbach, C. McBride, C. A. Zetlin and W. W. Morse. 1999b. Essential Fish Habitat Source Document: Longfin inshore squid, *Loligo pealeii*, life history and habitat characteristics. NOAA Tech. Mem. NMFS-NE-146.

Cargnelli, L. M., S. J. Griesbach, D. B. Packer and E. Weissberger. 1999c. Essential Fish Habitat Source Document: Atlantic surf clam, *Spisula solidissima*, life history and habitat characteristics. NOAA Tech. Mem. NMFS-NE-142.

Casterlin, M. E. and W. W. Reynolds. 1982. Thermoregulatory behavior and diel activity of yearling winter flounder, *Pseudopleuronectes americanus*. *Environ. Biol. Fishes* 7:177-180.

Centre for Cold Ocean Resources Engineering (C-CORE). 1995. Proposed marine mining technologies and mitigation techniques: A detailed analysis with respect to the mining of specific offshore mineral commodities. Contract report for U.S. Department of the Interior, Minerals Management Service, OCS Report MMS 95-0003, C-CORE Publication 96-C15, 280 pp. and appendices. In [Byrnes et al., 2004].

Chang, S., P. L. Berrien, D. L. Johnson and W. W. Morse. 1999. Essential Fish Habitat Source Document: Windowpane, *Scophthalmus aquosus*, life history and habitat characteristics. NOAA Tech. Mem. NMFS-NE-137.

Chesapeake Bay Program. 2004. "Cobia," http://www.chesapeakebay.net/cobia.htm. Accessed July 2005.

Chesapeake Bay Program. 2006. "Spanish mackerel,"
http://www.chesapeakebay.net/info/spanish_mackerel.cfm. Accessed October 2006.

Coastal Artificial Reef Planning Guide (CARPG). 1998. The joint artificial reef technical committee of the Atlantic and Gulf States Marine Fisheries Commissions.
http://www.gsmfc.org/pubs/SFRP/Coastal_Artificial_Reef_Planning_Guide_1998.pdf

Collette B. B. and G. Klein-MacPhee eds. 2002. Bigelow and Schroeder's Fishes of the Gulf of Maine. 3rd edition. Smithsonian Institution, Washington, D.C.

Costello, Charles. 2002. Phone conversation between Charles Costello of the Massachusetts Wetland Conservancy and ESS. December 2002.

Cross, J. N., C. A. Zetlin, P. L. Berrien, D. L. Johnson and C. McBride. 1999. Essential Fish Habitat Source Document: Butterfish, *Peprilus triacanthus*, life history and habitat characteristics. NOAA Tech. Mem. NMFS-NE-145.

Danish Institute for Fisheries Research (DIFR), Department of Marine Fisheries. Effects of marine windfarms on the distribution of fish, shellfish and marine mammals in the Horns Rev area. Report to ELSAMPROJEKT A/S. May 2000.

DeLeuw, Cather, & Company. 1991. Technical Memorandum #8, An inventory of selected aquatic and biological resources in the vicinity of the Quinnipiac River bridge.

Dernie, K. M., M. J. Kaiser and R. M. Warwick. 2003. Recovery rates of benthic communities following physical disturbance. *J. Anim. Ecol* 72 (6):1043-1056.

Department of Fisheries and Ocean Canada (DFO). 2006. Canadian Science Advisory Secretariat. http://www.mar.dfo-mpo.gc.ca/science/csas/status/1996/96_034e.html. Accessed September 2006.

ESS Group, Inc (ESS). 2007. Cape Wind Energy Project- Final Environmental Impact Report EOEA #12643, Development of Regional Impact CCC#JR#20084. 3 vols. Prepared for Cape Wind Associates, L.L.C., Boston, Mass. Wellesley, Mass.

Fahay, M. P., P. L. Berrien, D. L. Johnson and W. W. Morse. 1999. Essential Fish Habitat Source Document: Atlantic cod, *Gadus morhua*, life history and habitat characteristics. NOAA Tech. Mem. NMFS-NE-124.

Falkowski, P. G., C. N. Flagg, G. T. Rowe, S. L. Smith, T. E. Whitledge and C. D. Wirick. 1988. The fate of a spring phytoplankton bloom: export or oxidation? *Cont. Shelf Res* 8:547-584.

Festa, P. J. 1977. Observations on the summer flounder (*Paralichthys dentatus*) sport fishery in Great Bay, N.J. during summer of 1976 in reference to anoxic water conditions. Appendix VII. In Oxygen depletion and associated environmental disturbances in the Middle Atlantic Bight in 1976. U.S. Natl. Mar. Fish. Serv. Northeast Fish. Cent. Woods Hole Lab Ref. Doc. No. 81-25, 463-471.

Fishbase. 2006. "Species Summary - Spanish Mackerel," http://www.fishbase.org.search.cfm. Accessed October 2006.

Fritzsche, R. A. 1978. Development of fishes of the Mid-Atlantic Bight: An atlas of egg, larval, and juvenile stages. Vol. 5: Chaetodontidae through Ophidiidae. U.S. Fish Wildl. Serv. Biol. Serv. Porg. FWS/OBS-78/12.

Gabriel, W. L. 1992. Persistence of demersal fish assemblages between Cape Hatteras and Nova Scotia, northwest Atlantic. *J. Northwest Atl. Fish. Sci* 14: 29-46.

Godcharles, M. F. and M. D. Murphy. 1986. Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (south Florida) – king mackerel and Spanish mackerel. U.S. Fish Wildl. Serv. Biol. Rep. 82(11.58). U.S. Army Corps of Engineers, TR EL-82-4.

Goldberg, R., B. Phelan, J. Pereira, S. Hagan, P. Clark, A. Bejda, A. Calabrese, A. Studholme and K. Able. In preparation. Habitat-specific patterns of abundance and distribution of young-of-the-year winter flounder, *Psedopleuronectes americanus*, in three northeastern U.S. estuaries. U.S. Natl. Mar. Fish. Serv. Northeast Fish Sci. Cent., Milford Lab., Milford, Conn.

Gordon, R. B. and M. L. Spaulding. 1979. A nested numerical tidal model of the Southern New England Bight. Report to NOAA, Hampton, Va. from Univ. of Rhode Island, Kingston, R.I.

Gosner, K. L. 1978. The Peterson Field Guide Series. *A field guide to the Atlantic seashore from the Bay of Fundy to Cape Hatteras.* Boston: Houghton Mifflin Company.

Goud, M. R. and D. G. Aubrey. 1985. Theoretical and observational estimates of nearshore bedload transport rates. *Mar. Geol* 64: 91-111.

Grove, R. S., C. H. Sonu and M. Nakamura. 1989. Recent Japanese trends in fishing reef design and planning. *Bull. Mar. Sci* 44:984-996. In Effects of marine windfarms on the distribution of fish, shellfish and marine mammals in the Horns Rev area. Report to ELSAMPROJEKT A/S. May 2000.

Hall, S. J. 1994. Physical disturbance and marine benthic communities: life in unconsolidated sediments. *Oceanog. Mar. Biol. Ann. Rev* 32:179-239. In [Byrnes et al., 2004].

Harcourt, P., and T. Stanley. 2007. "How to Hide in the Ocean: Bioluminescence," http://www.sea.edu/academics/k12.asp?plan=hideinocean. Accessed March 20, 2007.

Hastings, M. and A. Popper. 2005. Effects of Sound on Fish., California DOT, Sacramento, Calif.

Hendrickson. L. C. and E. M. Holmes. 2004. Essential Fish Habitat Source Document: Northern Shortfin Squid, *Illex illecebrosus*, Life History and Habitat Characteristics. NOAA Technical Memorandum NMFS-NE-191. http://www.nefsc.noaa.gov/nefsc/publications/tm/tm191/tm191.pdf

Heyerdahl, E. G. and R. Livingstone, Jr. 1982. Atlantic cod, *Gadus morhua*. In Fish Distribution-MESA New York Bight Atlas Monograph 15 edited by M. D. Grosslein and T. R. Azarovitz, 70-72. N.Y. Sea Grant Institute, Albany, N.Y.

Hildebrand, S. F. and W. C. Schroeder. 1928. *Fishes of the Chesapeake Bay.* U.S. Bureau of Fisheries.

Hillson, C. J. 1982. *Seaweeds: A color-coded, illustrated guide to common marine plants of the East coast of the United States*. Pennsylvania State University Press, University Park and London.

Howe, A. B., T. P. Currier, S. J. Correira, and J. R. King. 1997. Resource assessments. Mass. Div. Mar. Fish. Proj. Rep. F-56-R (Seg. 2).

Howes, B. L., D. R. Schlezinger, J. A. Blake, and D. C. Rhoads. 1997. "Infaunal "recovery" as a control of sediment organic matter remineralization and the fate of regenerated nutrients in Boston Harbor," Abstracts, 84, In 14th Biennial Estuarine Research Federation (ERF) International Conference - The State of Our Estuaries, Oct. 12-16, 1997, Providence, R.I.

Hynes, H. B. N. 1970. *The ecology of running waters.* Toronto: University of Toronto Press.

Illingworth & Rodkin, Inc. 2001. Pile Installation Demonstration Project Construction Report. In San Francisco-Oakland Bay Bridge East Span Seismic Safety Project.

International Petroleum Industry Environmental Conservation Association (IPIECA). 2007. Biological impacts of oil pollution: fisheries. IPIECA Report Series, Volume 8.

Jacobson, L.D. 2005. Essential Fish Habitat Source Document: Longfin inshore squid, *Loligo pealeii*, life history and habitat characteristics. NOAA Tech. Mem. NMFS-NE-193.

Jersey Coast Angler's Association – Atlantic States Marine Fisheries Commission (JCAA-ASMFC). 2006. "Black sea bass, species profile," http://www.jcaa.org/ASMFC/9801BLSB.htm. Accessed September 2006.

Johnson, D. L., W. W. Morse, P. L. Berrien and J. J. Vitaliano. 1999. Essential Fish Habitat Source Document: Yellowtail flounder, *Limanda ferruginea*, life history and habitat characteristics. NOAA Tech. Mem. NMFS-NE-140.

Jordan, L. K. B, D. S. Gilliam, R. L. Sherman and R. E. Spieler. 2005. "Patch reef isolation affects fish assemblage structure - A study using replicate reef modules," http://www.nova.edu/ocean/ncri/projects/patchreef/. Accessed July 2005.

King, J. 2005. Personal Communication. Professor. Graduate School of Oceanography University of Rhode Island.

Kingsbury J. M., and P. Sze. 1997. *Seaweeds of Cape Cod and the Islands*. Jersey Shore, Pa.: Bullbrier Press.

Kurkul, P. 2002. Personal Communication. Conversation between Patricia Kurkul (Regional Administrator, National Marine Fisheries Service) and Christine Godfrey (U.S. Army Corps of Engineers). Conversation on June 27, 2002

Lange, A. M. T. 1982. Long-finned squid, *Loligo pealei*. In Fish distribution - MESA New York Bight Atlas Monograph 15 edited by M. D. Grosslein and T. R. Azarovitz, 133-35. N.Y. Sea Grant Institute, Albany, N.Y.

LGL Ltd. and JASCO Research Ltd. 2006. Environmental assessment of the BATHOLITHS marine seismic survey, inland waterways and near-offshore, central coast of British Columbia.

Limeburner, R., R. C. Beardsley and W. Esaias. 1980. Biological and hydrographic station data obtained in the vicinity of Nantucket Shoals, May 1978 – May 1979. Report WHOI-80-7. Woods Hole Oceanographic Institution, Woods Hole, Mass. Report to NOAA Sea Grant Program.

Lindberg, B., T. Frazer and W. Seaman. "Variation of reef dispersion to manage targeted fishery assemblages. Project number and duration: R/LR-B-23, 1989 – 1990," http://www.flseagrant.org/program_areas/coastal_habitats/publications/FSG_reef_research_throughtheyears.pdf

Long, E. R., D. D. MacDonald, S. L. Smith and F. D. Calder. 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. *Environ. Manage* 19 (1):81-97.

Lux, F. E. and F. E. Nichy. 1981. Movements of tagged summer flounder, *Paralichthys dentatus*, off southern New England. NOAA Tech. Rep. NMFS SSRF-752.

Malme, C. I., P. R. Miles, G. W. Miller, W. J. Richardson, D. G. Roseneau, D. H. Thomas, and C. R. Greene, Jr. 1989. Analysis and ranking of the acoustic disturbance potential of petroleum industry activities and other sources of noise in the environment of marine mammals in Alaska. OCS Study MMS 89-0006. Report to U.S. Minerals Management Service, Anchorage, Alaska.

Massachusetts Division of Marine Fisheries (MassDMF). 2001a. Personal Communication. Communication with V. Malkoski. November 2001

Massachusetts Division of Marine Fisheries (MassDMF). 2001b. E-mail Transmittal. Data tables on commercial fisheries. Contact – Robert Johnston, Field Office, Pocasset, Mass.

Marine Fisheries, 2005. "Species Profiles. Striped Bass," http://www.mass.gov/dfwele/dmf/recreationalfishing/stripedbass.htm#profile. Accessed June 12, 2005.

Maurer, D. and W. Leathem. 1981. Polychaete feeding guilds from Georges Bank, USA. *Marine Biology* 62:161-171.

Mayo, R. K. 1982. An assessment of the scup, *Stenotomus chrysops*, population in the southern New England and Mid-Atlantic regions. U.S. Natl. Mar. Fish. Serv., Northeast Fish. Cent. Woods Hole Lab. Ref. Doc. No. 82-46.

McCauley, R. D. 1994. Seismic surveys. In *Environmental Implications of Offshore Oil and Gas Development in Australia - The Findings of an Independent Scientific Review,* edited by J. M. Swan, J. M. Neff, and P. C. Young. Canberra, Australia: Australian Petroleum Exploration Association.

McCracken, F. D. 1963. Seasonal movements of the winter flounder, *Pseudopleuronectes americanus*, (Walbaum) on the Atlantic coast. *J. Fish. Res. Board Can* 20:551-586.

Mercer, L. P. 1989. Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (South Atlantic) – black sea bass. U.S. Fish Wildl. Serv. Biol. Rep. 82(11.99). U.S. Army Corps of Engineers, TR EL-82-4.

Mid-Atlantic Fishery Management Council. (MAFMC) 1996a. Amendment #8 to the summer flounder Fishery Management Plan: Fishery Management Plan and final environmental impact statement for the scup fishery. January 1996. MAFMC. Dover, Del.

Mid-Atlantic Fishery Management Council (MAFMC). 1996b. Amendment #6 to the Fishery Management Plan and the final environmental impact statement for the Atlantic mackerel, squid, and butterfish fisheries. September 1996. MAFMC. Dover, Del.

Mulkana, M. S. 1966. The growth and feeding habits of juvenile fishes in two Rhode Island estuaries. *Gulf Res. Rep* 2: 97-167.

Nakatani, R. E. and A. E. Nevissi. 1991. Effect of Prudhoe Bay crude oil on the homing of coho salmon in marine waters. *North American Journal of Fisheries Management* 11:160–166.

Neckles, H. A., F. T. Short, S. Barker and B. S. Kopp. 2005. Disturbance of eelgrass *Zostera marina* by commercial mussel *Mytilus edulis* harvesting in Maine: dragging impacts and habitat recovery. *Mar. Ecol. Prog. Ser* 285: 57-73.

Nedwell, J. and D. Howell. 2004. A review of offshore wind farm related underwater noise sources. Subacoustech Ltd. Report No. 544R0308.

Nedwell, J., B. Edwards, A. Turnpenny and J. Gordon. 2004. Fish and marine mammal audiograms: A summary of available information. Subacoustech Report Reference: 534R0214, September 2004. To: Chevron Texaco Ltd., TotalFinaElf Exploration UK Plc, DSTL, DTI and Shell U.K. Exploration and Production Ltd.

New England Fishery Management Council (NEFMC). October 7, 1998. Final – Amendment #11 to the Northeast Multispecies Fishery Management Plan; Amendment #9 to the Atlantic Sea Scallop

Fishery Management Plan; Amendment #1 to the Monkfish Fishery Management Plan; Components of the Proposed Atlantic Herring Fishery Management Plan for Essential Fish Habitat Incorporating the Environmental Assessment, Volume 1. Newburyport, MA, www.nero.nmfs.gov/ro/doc/yellowtail.pdf. Accessed September 2006.

Neville, W. C., and G. B. Talbot. 1964. The fishery for scup with special reference to fluctuations in yield and their causes. U.S. Fish Wildl. Serv. Spec. Sci. Rep. Fish. No. 459.

New England Sharks. 2006. "Capt. Tom's Guide to New England Sharks – Blue Shark," http://www.newenglandsharks.com/blue.htm. Accessed October 2006.

Newell, R. C., L. J. Seiderer and D. R. Hitchcock. 1998. The impact of dredging works in coastal waters: A review of the sensitivity to disturbance and subsequent recovery of biological resources on the sea bed. *Oceanogr. Mar. Biol.: an Ann. Rev* 36:127-178.

National Oceanic and Atmospheric Administration (NOAA). 1999a. Essential Fish Habitat Source Document: Windowpane, *Scopthalmus aquosus*, life history and habitat characteristics. NOAA Technical Memorandum NMFS-NE-137.

National Oceanic and Atmospheric Administration (NOAA). 1999b. Essential Fish Habitat Source Document: Winter Flounder, *Pseudopleuronectes americanus*, life history and habitat characteristics. NOAA Technical Memorandum NMFS-NE-138.

National Oceanic and Atmospheric Administration (NOAA). 2006. "Essential Fish Habitat Designations for New England Skate Complex, Maps of EFH: Designations for 7 skate species," http://www.nero.noaa.gov/ro/doc/skateefhmaps.htm. Accessed October 2006.

National Oceanic and Atmospheric Administration (NOAA). 2007. "Guide to Essential Fish Habitat Desiginations in the Northeastern United States," http://www.nero.noaa.gov/hcd/index2a.htm. Accessed August 2007.

National Oceanic and Atmospheric Administration Fisheries Service (NOAA Fisheries Service). 2006. "Guide to Essential Fish Habitat Descriptions," http://www.nero.nmfs.gov/ro/doc/list.htm. Accessed September 2006.

Northeast Utilities Service Company (NUSC). 1989. Winter flounder studies. In Monitoring the marine environment of Long Island Sound at Millstone Nuclear Power Station, 1989 Annual Report.

Packer, D. B., S. J. Griesbach, P. L. Berrien, C. A. Zetlin, D. L. Johnson and W. W. Morse. 1999. Summer flounder, *Paralichthys dentatus*, life history and habitat characteristics. NOAA Tech. Mem. NMFS-NE-151.

Packer, D. B., C. A. Zetlin and J. J. Vitaliano. 2003a. Essential Fish Habitat Source Document: Little Skate, *Leucoraja erinacea*, life history and habitat characteristics. NOAA Technical Memorandum NMFS-NE-175. http://www.nefsc.noaa.gov/nefsc/publications/tm/tm175/tm175.pdf

Packer, D. B., C. A. Zetlin and J. J. Vitaliano. 2003b. Essential Fish Habitat Source Document: Winter Skate, *Leucoraja ocellata*, life history and habitat characteristics. NOAA Technical Memorandum NMFS-NE-179. http://www.nefsc.noaa.gov/nefsc/publications/tm/tm179/tm179.pdf

Paglianti, A. and P. Domenici. 2006. The effect of size on the timing of visually mediated escape behaviour in staghorn sculpin *Leptocottus armatus*. *J. of Fish Biol* 68:1177-1191.

Passarelli, N., C. Knickle and K. DiVittorio. 2006. "Shortfin Mako. Ichthyology at the Florida Museum of Natural History – Education," http://www.flmnh.ufl.edu/fish/Gallery/Descript/ShortfinMako/Shortfinmako.html. Accessed September 2006.

Pereira, J. J., R. Goldberg, J. J. Ziskowski, P. L. Berrien, W. W. Morse and D. L. Johnson. 1999. Essential Fish Habitat Source Document: Winter flounder, *Pseudopleuronectes americanus*, life history and habitat characteristics. NOAA Tech. Mem. NMFS-NE-138.

Polovina, J. J. and I. Sakai. 1989. Impacts of artificial reefs on fishery production in Shimamaki, Japan. *Bull. Mar. Sci* 44:997-1003. In Effects of marine windfarms on the distribution of fish, shellfish and marine mammals in the Horns Rev area. Report to ELSAMPROJEKT A/S. May 2000. Danish Institute for Fisheries Research, Department of Marine Fisheries, Charlottenlund Castle, DK 2920 Charlottenlund.

Poole, J. C. 1962. The fluke population of Great South Bay in relation to the sport fishery. *N.Y. Fish Game J* 9:93-117.

Pratt, S. D. 1973. Benthic fauna. In Coastal and offshore environmental inventory – Cape Hatteras to Nantucket Shoals. Marine Publication Series No. 2, 5-1 to 5-55. University of Rhode Island, Kingston, R.I.

Reid, R., F. Almeida and C. Zetlin. 1999. Essential fish habitat source document: Fishery independent surveys, data sources, and methods. NOAA Tech. Mem. NMFS-NE-122.

Rhoads, D. C., P. L. McCall and J. Y. Yingst. 1978. The ecology of seafloor disturbance. *Am. Sci* 66:577-586.

Rhoads, D. C., and J. D. Germano. 1986. Interpreting long-term changes in benthic community structure: a new protocol. *Hydrobiologia* 142:291-308. In [Byrnes et al., 2004].

Richards, C. E. 1967. Age, growth and fecundity of the cobia, *Rachycentron canadum*, from the Chesapeake Bay and adjacent Mid-Atlantic waters. *Trans. Amer. Fish. Soc* 96:343-350.

Richardson, W. J., C. R. Greene, C. I. Malme and D. H. Thomson eds. 1995. *Marine mammals and noise*. San Diego: Academic Press, Inc.

Rosenberg, D. M. and V. H. Resh eds. 1993. *Freshwater biomonitoring and benthic macroinvertebrates*. New York: Chapman & Hall.

Ross, M. R. 1991. *Recreational fisheries of coastal New England*. Amherst: University of Massachusetts Press.

Sanders, H. L. 1956. The biology of marine bottom communities. *Bulletin of the Bingham Oceanographic Collection* 15:345-414.

Sanders, H. L. 1958. Benthic studies in Buzzards Bay. I. Animal-sediment relationships. *Limnol Oceanogr* 5:138-153.

Seascape Energy Ltd. (S.E., Ltd.). "Burbo Offshore Windfarm. Environmental Statement. September 2002," http://www.seascape-energy.co.uk/env_statement.html.

Shaffer, R. V. and E. L. Nakamura. 1989. Synopsis of biological data on the cobia, *Rachycentron canadum* (Pisces: Rachycentridae). NOAA Tech. Rep. NMFS 82.

Shark Trust (Shark Trust). 2006. "Shark Facts. Species Facts. Shortfin Mako Shark," http://www.sharktrust.org/content.asp?did=26284. Accessed November 2006.

Shedd Aquarium. 2007. "Explorers Guide: Whale Sharks," http://www.sheddaquarium.org/sea/fact_sheets.cfm?id=64. Accessed March 20, 2007.

Sherman, K., M. Grosslein, D. Mountain, D. Busch, J. O'Reilly and R. Theroux. 1988. The continental shelf ecosystem off the Northeast coast of the United States. In *Ecosystems of the World vol 27*, edited by H. Postma and J.J. Zijlstra, 279-337. The Netherlands: Elsevier Press.

SRS Technologies. 2004. San Francisco-Oakland Bay Bridge East Span Seismic Safety Project. Revised Marine Mammal Monitoring Plan.

Steimle, F. W., C. A. Zetlin, P. L. Berrien and S. Chang. 1999a. Essential Fish Habitat Source Document: Black sea bass, *Centropristis striata*, life history and habitat characteristics. NOAA Tech. Mem. NMFS-NE-143.

Steimle, F. W., C. A. Zetlin, P. L. Berrien, D. L. Johnson and S. Chang. 1999b. Essential Fish Habitat Source Document: Scup, *Stenotomus chrysops*, life history and habitat characteristics. NOAA Tech. Mem. NMFS-NE-149.

Street, R. 1999. "*Prionace glauca*, Animal Diversity Web," http://animaldiversity.ummz.umich.edu/site/accounts/information/Prionace_glauca.html. Accessed October 2006.

Studholme, A. L., D. B. Packer, P. L. Berrien, D. L. Johnson, C. A. Zetlin and W. W. Morse. 1999. Essential Fish Habitat Source Document: Atlantic mackerel, *Scomber scombrus*, life history and habitat characteristics. NOAA Tech. Mem. NMFS-NE-141.

The Hudson River Almanac. 1995. http://www.hudsonriver.com/almanac/0997alm.htm. Accessed September 2006.

Theroux, R. B. and R. L. Wigley. 1998. Quantitative composition and distribution of the macrobenthic invertebrate fauna of the continental shelf ecosystems of the northeastern United States. NOAA Tech. Rep. NMFS 140. NOAA, Washington, D.C.

University of California at San Diego, Ocean Acoustic Observatories. 2005. "Alternate Source Test-Office of Naval Research Pilot Project," http://atoc.ucsd.edu/ASTpg.html.

USACE Dredging Operations and Environmental Research Program (USACE DOER). 2005. Sedimentation: Potential Biological Effects of Dredging Operations in Estuarine and Marine Environments. ERDC TN-DOER-E20. May 2005.

Van Rijn, L. C. 1993. *Principles of sediment transport in rivers, estuaries and coastal seas*. The Netherlands: Aqua Publications.

Vella, G. 2002. Offshore Wind: The Environmental Implications. Utilities Project, Volume 2. University of Liverpool.

Villard-Bohnsack, M. 2003. *Illustrated key to seaweeds of New England* 2d ed. A Publication of the Rhode Island Natural History Survey, Kingston, R.I.

VIMS. 2006. "Cobia." http://www.vims.edu/adv/cobia. Accessed September 2006.

Virginia Tech Conservation Management Institute (VTCMI). 1996. "Marine and coastal species information system. Spanish Mackerel – life history." http://fwie.fw.vt.edu/WWW/macsis/lists/TSNL0105.htm. Accessed October 2006.

Webb, P. W. 1982. Avoidance responses of fathead minnow to strikes by four teleost predators. *J. of Comp. Physiol* 147A:371-78.

Westerberg, H. 1999. Impact studies of sea-based windpower in Sweden. Technische Eingriffe in Marine Lebensraume.

Whitlatch, R. B., A. M. Lohrer, S. F. Thrush, R. D. Pridmore, J. E. Hewitt, V. J. Cummings and R. N. Zajac, 1998. Scale dependent benthic recolonization dynamics: life stage-based dispersal and demographic consequences. *Hydrobiologia* 375/376:217-226. In [Byrnes et al., 2004].

Wigley, R. 1968. Benthic invertebrates of the New England fishing banks. *Underwater Naturalist. American Littoral Society* 5(1).

Williams, G. C. 1975. Viable embryologenesis of the winter flounder, *Pseudopleuronectes americanus*, from –1.8 – 15°C. *Mar. Biol (Berl)* 33(1):71-74.

Wilson, C. A., A. Pierce, and M. W. Miller. 2003. Rigs and reefs: A comparison of the fish communities at two artificial reefs, a production platform, and a natural reef in the northern Gulf of Mexico. Final Report. Prepared under MMS Contract 14-35-0001-30660-19960 by Coastal Fisheries Institute, Louisiana State University. OCS Study MMS 2003-009.

Zajac, R. N. 1998. A review of research on benthic communities conducted in Long Island Sound and an assessment of structure and dynamics. In Long Island Sound Environmental Studies, U.S. Geological Survey Open-File Report, 98-502.

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APPENDIX A
Landings Data

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, the main source of resource data available in Nantucket Sound is from the MA DMF independent fisheries monitoring program. For more details on these datasets, please see Report No. 4.2.7-1. 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 Vessel Trip Reports (VTRs) by federally-permitted vessels fishing in Nantucket Sound
- Commercial catch data monitored by MA DMF and reported by state-permitted vessels fishing in Nantucket Sound
- Recreational fishery information obtained from the NOAA Fisheries Marine Recreational Fisheries Statistical Surveys (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
- MA DMF bi-annual resource trawls for Nantucket Sound (information gathered is independent of commercial fisheries monitoring)

A summary table listing which databases reported the presence of the EFH designated species is provided in table A-1. The detailed reported landings and catch data for these species according to the NOAA and MA DMF databases are summarized after the table.

Table A-1. Summary of Federal and State Fisheries Databases Reporting the Presence of EFH Designated Species

EFH Species	NOAA VTR Commercial	NOAA VTR Charter	NOAA MRFSS recreational	DMF Commercial	DMF Resource Trawl
Atlantic cod	X	-	X	X	X[1,2]
Scup	X	X	X	X	X[1,2]
Black sea bass	X	X	X	X	X[1,2]
Winter flounder	X	X	X	X	X[1,2]
Summer flounder	X	X	X	X	X[1,2]
Windowpane	X	-	X	X[3]	X[1,2]
Yellowtail flounder	X	-	X	X	X[1]
Atlantic butterfish	X	X	X	X	X[1,2]
Atlantic mackerel	X	X	X	X	X[1]
King mackerel	-	-	-	X	-
Spanish mackerel	X	X	X	X	-
Cobia	-	-	-	-	-
Blue shark	-	-	X[3]	-	-
Shortfin mako shark	-	-	X	-	-
Bluefin tuna	X	-	X	-	-
Little skate	X[3]	X[3]	X	X[3]	X[1,2]

Table A-1. Summary of Federal and State Fisheries Databases Reporting the Presence of EFH Designated Species

EFH Species	NOAA VTR Commercial	NOAA VTR Charter	NOAA MRFSS recreational	DMF Commercial	DMF Resource Trawl
Winter skate	X[3]	X[3]	X	X[3]	X[1,2]
Long-finned squid	X	X	-	X[3]	X[1,2]
Short-finned squid	X	X	-	X[3]	X[1]
Surf clam/sea clam	X[3]	-	-	X	X[1,2]
X=reported					
-=not reported					
1=SPRING					
2=FALL					
3=NOT SPECIFIC SPECIES					

Atlantic cod: This species was documented by the NOAA VTR commercial landings database, NOAA Marine Recreational Fisheries Statistics Survey (MRFSS) database, DMF commercial database, and the DMF 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 DMF 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 DMF 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, DMF commercial database, and the DMF 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 DMF 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 DMF 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, DMF commercial database, and the DMF 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 DMF 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 DMF 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, DMF commercial database, and the DMF 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 DMF 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 DMF 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 DMF 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, DMF commercial database, and the DMF 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 DMF 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 DMF 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 DMF 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, DMF commercial database, and the DMF 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 3 from private/rental boats.
- During the 27 years of DMF 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, DMF commercial database, and the DMF 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 DMF 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 DMF 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 DMF 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, DMF commercial database, and the DMF 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 DMF 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 DMF 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, DMF commercial database, and the DMF 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 DMF 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 DMF 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 DMF 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 DMF fall resource trawl data in Nantucket Sound over the 27 year period.

King mackerel: This species was documented by the DMF commercial database only.

- During the fifteen years of DMF 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 DMF 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 DMF 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 kikglograms) 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 DMF 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 DMF commercial database reported landings for unspecified skate species. The NOAA MRFSS database and the DMF 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 DMF 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 DMF 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 DMF commercial database reported landings for unspecified skate species. The NOAA MRFSS database and the DMF 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 DMF 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, DMF commercial database (not specific to species), and the DMF 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 DMF 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 DMF 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, DMF commercial database (not specific to species), and the DMF 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 DMF 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 DMF 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), DMF commercial database, and the DMF 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 DMF 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 DMF 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.

APPENDIX B
EFH Species Occurrence and Impact Matrices

Table B-1. Early Benthic and Pelagic Life Stages of Species with Designated EFH Potentially Present in the Proposed Action Area

Species	Eggs (E)	Larvae (L)	Potential Time of Year Present in Nantucket Sound
Early Benthic Life Stages			
Winter flounder	X	X	February – July
Early Pelagic Life Stages			
Atlantic butterfish	X	X	April to August
Atlantic mackerel	X	X	Unknown/water temperatures between 5-22.7^{o}C
Black Sea Bass		X	August – September
Summer Flounder	X	X	October - May
Winter Flounder		X	L: March – July. Larvae swim upwards, then sink.

X = Potentially Present in proposed action area
R = Potentially Present in proposed action area, but would be considered rare
Note: Although king mackerel, Spanish mackerel and cobia have designated EFH for eggs and larval stages, further analysis indicates that they are unlikely to occur in Nantucket Sound (see Section 4.2.4 of the EFH Assessment)

Table B-2. Older Benthic and Pelagic Life Stages of Species with Designated EFH Potentially Present in the Proposed Action Area

Species	Juvenile (J)	Adult (A)	Potential Time of Year Present in Nantucket Sound
Older Benthic Life Stages			
Atlantic cod		X	October – April. Benthopelagic
Black Sea Bass	X	X	May – October
Little skate	X	X	Year round
Scup	X	X	May to October
Surf clam	X	X	Year-round
Summer Flounder	X	X	May – October
Windowpane Flounder		X	Year round
Winter Flounder	X	X	Year round
Winter Skate	X	X	Year round
Older Pelagic Life Stages			
Atlantic butterfish	X	X	May – November
Atlantic mackerel	X	X	J: August - November; A: March, April, Oct-Dec
Blue shark		R	Summer months
Cobia	R,T	R,T	Spring and Summer months
King mackerel	R,T	R,T	Rare occurrences
Long-finned squid	X	X	May – August
Short-finned Squid	R	R	Spring months
Shortfin mako shark	R		Summer months
Spanish mackerel	R	R	Spring and Summer months

X = Potentially Present in proposed action area
T = Potentially Transient in proposed action area
R = Potentially Present in proposed action area, but would be considered rare
Notes:
Although juvenile yellowtail flounder had designated EFH within the mapped grid of 10 x 10 minute squares encompassing the Project area, the detailed EFH description indicates that NMFS has not appointed specific regions of EFH in Nantucket Sound for juvenile yellowtail flounder.[1] Therefore, this species and lifestage is not included in this summary table.

Although juvenile and adult bluefin tuna had designated EFH within the mapped grid of 10 x 10 minute squares encompassing the Project area, the detailed EFH description indicates that NMFS has not appointed specific regions of EFH in Nantucket Sound for juvenile or adult bluefin tuna[2]. Therefore, these lifestages for bluefin tuna are not included in this summary table.

[1] [NEFMC] New England Fishery Management Council. October 7, 1998. Final – Amendment #11 to the Northeast Multispecies Fishery Management Plan; Amendment #9 to the Atlantic Sea Scallop Fishery Management Plan; Amendment #1 to the Monkfish Fishery Management Plan; Components of the Proposed Atlantic Herring Fishery Management Plan for Essential Fish Habitat Incorporating the Environmental Assessment, Volume 1. Newburyport, MA, [Online] URL: www.nero.nmfs.gov/ro/doc/yellowtail.pdf. Accessed October 2006.

[2] NOAA Fisheries. 2006. Atlantic Bluefin Tuna – Life History, Summary Tables, Biological Information. [Online] URL: http://www.nmfs.noaa.gov/habitat/habitatprotection/profile/hms/atlantic_bluefin_tunahome.htm. Accessed September 2006.

Table B-3. Potential Impacts to Benthic and Pelagic Life Stages of Species with Designated EFH Potentially Present in the Proposed Action Area

	Level of Impact to Life Stages*				
Potential Impact	**Benthic Early**	**Pelagic Early**	**Benthic Older**	**Pelagic Older**	**Description**
Permanent EFH loss from WTG and ESP monopile installation	MINOR	NEGLIGIBLE	MINOR	NEGLIGIBLE	0.67 acres or 0.0042% of the Project area.
Temporary finfish/benthic habitat loss (Scour Control; Jack-up barge for WTG and ESP installation; jet plow installation of inner-array cables; jet plow installation of 115kV transmission cable system, vessel positioning, anchoring)	MINOR	NEGLIGIBLE	MINOR	NEGLIGIBLE	820 acres or 5.1% of the proposed action area using a combination of scour control mats and rock armor; 866 acres or 5.4% of the proposed action area using only rock armoring. Greatest impacts to demersal eggs and larvae if present during construction. Pelagic eggs and larvae less affected. Greatest areal impacts to surficial benthic habitat for early demersal life stages and benthic organisms would occur from anchoring activities. Some mortality or dispersal of benthic organisms (prey for fish) may temporarily disrupt feeding for some benthic-oriented juvenile and adult fish in the proposed action area. Pelagic-oriented juveniles and adults less affected by temporary benthic habitat loss. Temporary habitat impact would only affect a small portion (~5%) of the proposed action area; therefore, sufficient habitat and food base is expected to be available for benthic-oriented juvenile and adult fish species in areas adjacent to the proposed action area and in other parts of the Sound. Disturbed benthic habitat is expected to be recolonized by benthos within a time period of 1 to 2 years.

Table B-3. Potential Impacts to Benthic and Pelagic Life Stages of Species with Designated EFH Potentially Present in the Proposed Action Area

	Level of Impact to Life Stages*				
Potential Impact	**Benthic Early**	**Pelagic Early**	**Benthic Older**	**Pelagic Older**	**Description**
Temporary finfish/benthic habitat loss (Nearshore HDD installation - Lewis Bay)	MINOR	NEGLIGIBLE	MINOR	NEGLIGIBLE	0.12 acres. Minor, temporary impact since activity is limited and contained. Impacts to winter flounder avoided through TOY restrictions (see ESS 2007, Section 3.8.4.5).
Mortality/Injury/Displacement	MINOR	MINOR	MINOR	NEGLIGIBLE	Demersal early life stages most affected (some physical abrasion, burial, mortality, displacement) if present during construction. Greatest areal impacts to demersal eggs and larvae would occur from anchoring activities during construction. Pelagic eggs and larvae less susceptible to these impacts. Those in direct path may experience some limited injury/mortality. No measurable impacts expected to adult and juvenile pelagic finfish since these life stages are mobile in water column and can move away from disturbances associated with construction. Adult and juvenile demersal finfish in direct path of bottom disturbing activities may experience some direct injury or mortality, but they too should be able to move away. During winter construction periods, demersal fish may experience higher levels of injury/mortality due to sluggish response under cold water conditions. Displacement of juvenile and adult finfish expected to be temporary and localized. (See ESS 2007, Sections 3.8.4.2 and 3.8.4.10).

Table B-3. Potential Impacts to Benthic and Pelagic Life Stages of Species with Designated EFH Potentially Present in the Proposed Action Area

	Level of Impact to Life Stages*				
Potential Impact	**Benthic Early**	**Pelagic Early**	**Benthic Older**	**Pelagic Older**	**Description**
Elevated TSS levels (installation of monopile foundations, scour control mats, inner-array, 115kV transmission cable systems, HDD borehole ends)	MINOR	MINOR	MINOR	NEGLIGIBLE	Temporary and localized increase in suspended sediment concentrations due to equipment and sediment conditions in the proposed action area. Sediments disturbed during construction are expected to settle quickly (see Section 5.3.2.7 in this final EIS and Report No. 4.1.1-2). Sediment suspension from HDD operations extremely minimal since these activities would be contained within cofferdam. Demersal early life stages most affected - those in immediate vicinity of construction may experience mortality or injury through burial or smothering. Pelagic eggs and larvae may be temporarily affected/displaced. Benthic and pelagic adults and juveniles are mobile and capable of moving away from disturbed areas and elevated TSS concentrations. Little direct impact expected to adults and juveniles from elevated TSS; however, elevated TSS concentrations could indirectly impact these life stages by making it more difficult to navigate, forage or find shelter. Fish should only be affected temporarily and are expected to rapidly return to area.
Ambient sediments/Sediment Contaminants	NEGLIGIBLE	NEGLIGIBLE	MINOR	NEGLIGIBLE	No impact (see Section 5.3.2.7 of this final EIS).
Bentonite Release	MINOR	NEGLIGIBLE	MINOR	NEGLIGIBLE	Minimal impact with protection measures in place (see ESS 2007, Section 3.8.4.4).

Table B-3. Potential Impacts to Benthic and Pelagic Life Stages of Species with Designated EFH Potentially Present in the Proposed Action Area

	Level of Impact to Life Stages*				
Potential Impact	**Benthic Early**	**Pelagic Early**	**Benthic Older**	**Pelagic Older**	**Description**
Impingement/Entrainment of Fish Eggs/Larvae from Vessel Water Withdrawals/Water Withdrawals Associated with Cable Jetting	MINOR	MINOR	MINOR	NEGLIGIBLE	Vessel water withdrawals expected to be periodic near-surface water withdrawals. Jet plow withdrawals expected at or near the water surface. Jet plow progresses relatively rapidly and any impacts expected to be short-term in any one area.
Acoustic Injury or Damage from Monopile Driving	MINOR	MINOR	MINOR	NEGLIGIBLE	No peer-reviewed studies of effect of pile driving sound on fish eggs/larvae. Limited impact to benthic or pelagic adults/juveniles with protection measures in place (see ESS 2007, Section 3.8.4.6.2).
Acoustic Harassment from Monopile Driving	N/A	N/A	MINOR	MINOR	No peer-reviewed studies of effect of pile driving sound on fish eggs/larvae. Minimal impact (temporary avoidance) to benthic or pelagic adults/juveniles with protection measures in place. Pile driving sound levels cannot be reliably estimated for distances closer than 30 m (98 ft) due to near-field effects (see Section 5.3.2.7 of this final EIS).
Acoustic Harassment from Vessels and Cable Laying	N/A	N/A	MINOR	MINOR	No peer-reviewed studies of effect of vessel sounds on fish eggs/larvae. Minimal impact to benthic or pelagic adults/juveniles with protection measures in place (see ESS 2007, Sections 3.8.4.6.3 and 3.8.4.6.4).
Acoustic Injury or Harassment from Project Operation.	MINOR	NEGLIGIBLE	MINOR	NEGLIGIBLE	See ESS 2007, Section 3.8.4.6.5.
Hardened structures/reef effect	MINOR	NEGLIGIBLE	MINOR	MINOR	See ESS 2007, Section 3.8.4.7.
EMF	MINOR	NEGLIGIBLE	MINOR	NEGLIGIBLE	No impact (see Section 5.3.1.7 of this final EIS and Report No. 5.3.2-3).

Table B-3. Potential Impacts to Benthic and Pelagic Life Stages of Species with Designated EFH Potentially Present in the Proposed Action Area

	Level of Impact to Life Stages*				
Potential Impact	**Benthic Early**	**Pelagic Early**	**Benthic Older**	**Pelagic Older**	**Description**
Rotor Shadow Effects	N/A	N/A	MINOR	NEGLIGIBLE	Periodic motion of shadows can be seen ahead of time; with increase in speed shadows become less distinct and harder to perceive; dappling effect of light and dark through water column and on seafloor similar to existing light patterns.
Water flow, currents, waves, sediment transport	MINOR	NEGLIGIBLE	MINOR	NEGLIGIBLE	No impact (see ESS 2007, Section 3.8.4.9).
Spills and Accidental Releases of Potential Contaminants	MINOR	MINOR	MINOR	MINOR	Equipment well-maintained and personnel trained; service vessels equipped with spill handling equipment; waste collection systems installed on each WTG; a SPPC would be developed in accordance with MMS regulations.

*Level of Impact Definitions

NA = Not Applicable

Negligible - No measurable impacts.

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

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

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