ESS Group, Inc.

Appendix 3.9-B

Potential Impacts to Predator-Prey Relationships as a Result of the Proposed Cape Wind Project in Nantucket Sound.

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1.0 INTRODUCTION

Several comments received in regard to the proposed Cape Wind Project have hypothesized that the addition of 130 monopile foundations to Nantucket Sound would result in a so-called “reef” effect due to the increased availability of hard substrate for sessile organisms that may colonize these structures and ultimately, that this would alter predator-prey relationships in Nantucket Sound. The diversity of the benthic community that might colonize the monopiles will depend on the substrate characteristics and a number of environmental factors including exposure to waves, current, scour, etc., similar to the variables that affect colonization of most marine habitats. Once established, the attached community is expected to include sessile animal and plant species and small mobile invertebrates. Over time, the presence of these fouling communities is expected to attract small fish species, which could in turn lead to the attraction of larger benthic or pelagic fish, and eventually, the attraction of sea birds (Elsam Engineering A/S and ENERGI E2 A/S 2005). Some commentors have also questioned the degree to which marine mammals would be attracted to the proposed wind farm. The extent to which attraction occurs, however, will be dependent upon how hospitable the surface of the monopile is for colonization. In general, substrate that has an irregular or rough surface or that offers organisms structural complexity to avoid predation and to escape from high current velocities and scour is typically more suitable for colonization and ultimately the formation of reef-like communities. The monopile foundations were selected to be smooth and devoid of complexity, unlike the scaffolding typically used for oil platforms (MMS, 2000). The monopiles will provide vertical habitat that will be colonized by organisms, however, the degree of colonization is likely to be minimal due to their smooth cylindrical form. Research conducted during the summer of 2005 on the pilings of the Cape Wind meteorological tower in Nantucket Sound showed that organisms do colonize pilings placed in Nantucket Sound, as anticipated, however, the degree of colonization is not extensive, despite the fact that these structures had been available for colonization for more than two years. Table 1 lists the species and number of individuals per square meter that colonized the meteorological tower and were recorded during the summer of 2005. Although additional time for colonization is likely to result in greater densities and species diversity than was observed during this initial investigation, it is also likely that these communities would be scoured away on a regular basis during periods of intense currents or wave activity associated with storm events.

2.0 PHYSICAL CONDITIONS

In the Horseshoe Shoal area, Nantucket Sound’s generally smooth, sandy bottom is predominantly comprised of medium-grained poorly sorted sands. Fine sands and silty sands surround the shoal in deeper waters. Additionally, localized fractions of silt, gravel, and/or cobbles, consistent with glacial drift, have also been identified in surficial and subsurface sediments in the Project area. Maximum water depths in the Horseshoe Shoal area were measured at approximately 60 feet (18.3 meters (m)) at MLLW and occur between the northern and southern legs of the shoal; and measured water depths were approximately 50 feet (15.2 m) at MLLW in an east-west trending natural channel feature that exists on the shoal’s southern leg. Average depths over most of the shoal were documented to be less than 20 feet (approximately 6 m). Tidal current velocities at these depths were calculated to be approximately two feet/second (0.61 m/second).

In order to predict predator-prey interactions that are likely to occur in the proposed wind park, a literature review of related reports was conducted for existing wind parks, two of which exist in Denmark. The Horns Rev and Nysted wind parks were constructed in the summers of 2002 and 2003, respectively. In order to demonstrate the comparability of Nantucket Sound to the marine environments of the Danish wind parks, their physical conditions are described herein. Sediments at Denmark's Horns Rev wind park are predominantly comprised of sand; however, the surrounding vicinity of the wind park contains a mixture of sand, gravel, pebbles, and boulders with intermittent pockets of fine-grained material. Water depths are relatively shallow, and range between approximately 6 and 14 m deep (Bio/consult as 2005). Horns Rev's approximate water depths are slightly shallower than the depths at Horseshoe Shoal (which ranged between approximately 15 and 18 m deep). However, while the currents at Horseshoe Shoal are primarily tidal-driven, Horns Rev tidal currents are mainly wind-driven (Elsamprojekt A/S 2000).

Sediments at Denmark's Nysted wind park are predominantly comprised of medium-grained sand particles, with finer-grained sand particles and a higher silt/clay content bordering the park. Water depths are shallower in comparison to that of Horseshoe Shoal and Horns Rev, in that the depth was measured to range between approximately 6 and 9 m deep (Oakley and Gavilán 2000).

3.0 WIND TURBINE STRUCTURES AND FOUNDATIONS

A meteorological tower was installed at Cape Wind's proposed project site in Nantucket Sound to monitor the site's atmospheric and oceanic conditions. While the meteorological tower is supported by a tripod foundation, it is similar to the proposed monopile foundations in that they both have smooth steel surfaces that lack structural rugosity. Scour control mats are currently in place at the meteorological tower, and are proposed for the monopile foundations. The use of synthetic fronds designed to mimic seafloor vegetation would afford the necessary scour protection while minimizing potential alterations to the benthic and fish communities typically associated with Horseshoe Shoal. This is because the synthetic fronds (scour control mats), when secured to the bottom as a network, trap sediments and eventually become buried. This scour protection approach is more consistent with the low bottom relief of Horseshoe Shoal than traditional boulder revetment or stone-filled concrete platforms.

In the event that a rock armor alternative is used for scour protection at the proposed Project site, the expectation remains that a minimal attraction of species would occur, and therefore Nantucket Sound's current predator-prey relationships would not be significantly altered. The Project alternately proposes to first install the monopile structures and allow the anticipated scour to take place around the structures' foundations. Once the scour occurs, a layer of stone and gravel, approximately 7 to 12 cm, or 3 to 5 inches (in), in diameter would be used to partially backfill the scour hole. The stone and gravel layer would serve a dual purpose: first, to prevent the underlying natural sediment from being removed by wave action and second, to support the uppermost layer from sinking into the natural sediment. The uppermost layer of larger rock armor, approximately 3 to 4 feet thick, would entirely cover the bottom fill layer and would be flush with the surrounding seabed rather than being raised above the seabed in the same manner as the Horns Rev and Nysted monopile foundations, which are discussed below. It is anticipated that the rock armor has the potential to become sand-covered and mimic the surrounding environment, but that the rocks would most likely be exposed, as the sand is expected to be transported by the site's tidal-driven currents. For more specific details refer to Appendix 3.14-E, Conceptual Rock Armor Scour Protection Design.

The monopile structures introduced to the predominantly sandy environment of the Horns Rev wind park are similar to the Cape Wind meteorological tower and the proposed wind turbines for Horseshoe Shoal in that they have smooth steel surfaces that lack structural rugosity. They differ, however, in the methods of scour protection. The foundations of the Horns Rev monopile structures (Figure 1) are approximately 4 m in diameter and are protected by stone mattresses that are raised 1.3 m above the seabed. The stone mattresses' base layer is 0.5 m thick and contains stones that measure 3-20 centimeters (cm) in diameter. The base layer is covered by a 0.8 m thick layer of larger stones, which are approximately 55 cm in diameter. The entire base of the scour protection can reach approximately 27 m in diameter (Bio/consult as 2005). The stone mattresses are raised above the surface of the seabed in a contained, orderly placement, rather than existing simply as a rubble pile. The installation of the raised stone mattresses create new hard-bottom habitat that is filled with habitat-providing crevices in an otherwise sandy bottom environment.

The wind turbine structures that make up the Nysted wind park also have smooth, cylindrical surfaces. The scour control methods utilized at both of the Danish wind farms are somewhat similar; however, each of the sites' scour control methods differ slightly in their arrangement. The turbines at Nysted (Figure 1) are set in concrete foundations that are raised 3 m above the seabed, are hexagon shaped, and are divided into six gravel and stone-filled cells. The stones that comprise the uppermost layer are an average of 70 cm in diameter. Each of the hexagon-shaped foundations is wholly or partially surrounded by additional scour protection, therefore reaching a total diameter of approximately 25 m (Birklund and Petersen 2004). Similar to the Horns Rev wind park, rather than existing as a disorderly rubble pile at the base of the monopile, the scour protection foundations exist above the surface of the seabed in an organized radius around the base of the monopile.

4.0 BENTHIC AND FOULING COMMUNITIES

In June 2005, more than two years following the Cape Wind meteorological tower's installation, macroinvertebrate sampling on the tower pilings yielded over ten taxa including seven species that were not observed during baseline surveys at the meteorological tower's location on Horseshoe Shoal (Table 1). The seven species, or those that were observed during the June 2005 sampling event, included blue mussel (*Mytilus edulis*), sea flea (*Photidae spp.*), sea slug (*Sacoglossa spp.*), mud worm (*Polydora spp.*), large-eyed feather duster worm *(Potamilla reniformis*), purse sponge (*Scypha ciliata*), and sea spider (*Tanystylum orbiculare*). Due to the location of the meteorological tower within the Project site and the structural similarities between the tower pilings and the monopile foundations, the 26 species listed in Table 1 is expected to be an accurate representation of the species that would colonize the installed monopile foundations. The greatest amount of fouling, of both new species and those species that had been previously observed at the Cape Wind meteorological tower, was recorded toward the bottom of the pole, closest to the substrate. However, several species including blue mussels, barnacles (*Balanus spp.*), and several species of amphipods and decapods were observed along the full length of the tower's submerged support legs (Table 1).

Additional organisms that may initially be supported by such structures are likely to include a variety of species of algae, hydroids, sponges, tunicates, bryozoans, and anemones, all of which occur at the sporadic rocky outcrops and other areas of hard substrate within Nantucket Sound. Additional organisms, such as a variety of species of crabs, gastropods, nudibranchs, polychaetes, oligochaetes, and nematodes may also utilize the structures once a fouling community becomes established.

Similar to observations of the pilings of the Cape Wind meteorological tower in Nantucket Sound during 2005, the installation of monopile foundations at existing European wind farms, (specifically Denmark's Horns Rev and Nysted offshore wind farms) have created habitat in the form of hard-bottom attachment sites for benthic organisms that require fixed (non-sand) substrates.

Two annual post-construction/operation surveys (2003 and 2004) of the monopile communities at the Horns Rev wind farm have identified over 11 taxa of seaweeds and 70 taxa of faunal invertebrates, 12 of which were mobile species. In the 2004 survey, 14 epifaunal species, which had not previously been present at the predominantly sandy habitat, were recorded at the Horns Rev's newly introduced hard-bottom habitat. Horns Rev monitoring reports clearly state that the introduction of the monopile foundations and the associated scour control devices, have effectively changed the substrate from pure sand to foundations of steel, gravel, and stones. Additionally, the monitoring reports document that the native infaunal communities have been replaced with epifaunal communities typical of a hard-substrate environment. It should be noted that in the year between the two surveys, significant population and species variations were observed, as well as variations in temporal and spatial distribution. These changes may be the result of regular scouring and recolonization cycles, which result from heavy storms and severe winter conditions. Studies have indicated that while heavily populated fouling communities can become established within as little as a year following the introduction of new hard-bottom habitat, that stability in fouling communities is not attained until approximately five to six years following the structure's establishment (Bio/consult as 2005).

In 2003 at the Nysted wind park, a post-construction survey was conducted to specifically assess the development of the fouling communities on the monopile foundations and scour protection platforms. Survey results found that a dense layer of blue mussels and barnacles (*Balanus improvisus*) established on the foundations uppermost-submerged portion. In addition, present at this portion of the pole were small colonies of red macroalgae, encrusting bryozoans, and white polyps. As water depth increased, the colonization of blue mussels and barnacles decreased, creating space for the colonization by macroalgae, which increased and became more species-diverse with depth. Species of green and brown algae were established along the monopile foundation and the anti-scour concrete and stone base platform. Other invertebrates identified along the base of the monopile foundations, and the raised scour protection platforms include species of amphipods, polycheates, bivalves, and gastropods (Birklund and Petersen 2004). It is unclear in the monitoring report as to which of the observed species were new to the area as a result of the monopile introductions. However, given the fact that the Nysted wind farm is a naturally sandy environment, it can be assumed that both the Nysted and Horns Rev sites are very similar; the commonly hard-bottom inhabitants were not previously present before the installation of the monopiles.

It should also be noted that the Horns Rev and Nysted wind farms used raised hard-bottom platforms to prevent scour, and that these platforms offer a greater degree of substrate complexity than would be offered by Cape Wind's proposed scour control mats, or alternately proposed rock armor backfill. Should the alternate backfill method be incorporated by Cape Wind, the rock armoring would be installed flush with the surrounding seabed. Therefore, in comparison to that of the Danish wind farms, the amount of resulting hard-bottom colonization would be expected to be less, as the Horns Rev and Nysted sites provide a greater hard-bottom surface area on which colonization occurs.

5.0 FISH

The installation of monopile foundations in Nantucket Sound will create smooth hard-bottom habitat within the project site, therefore having the potential to create localized changes to finfish community assemblages. However, the overall environment and finfish species composition in the Project area and Nantucket Sound is not predicted to substantially change from pre-Project conditions. Based upon the macroinvertebrate species observed on the pilings of the Cape Wind meteorological tower, and those fouling species known to be common in the Project Area, the following fish species, at one or all stages in their life cycles, are anticipated to potentially prey on the observed and identified organisms: American eel (*Anguilla rostrata*), Atlantic herring (*Clupea harengus*), Atlantic menhaden (*Brevoortia tyrannus)*, Atlantic sturgeon (*Acipenser oxyrhynchus*), spiny dogfish (*Squalus acanthias*), striped bass (*Morone saxatilis)*, American shad (*Alosa sapidissima*), alewife (*Alosa pseudoharengus*), inland silverside (*Menidia beryllina*), Atlantic silverside (*Menidia menidia*), weakfish (*Cynoscion regalis*), monkfish (*Lophius americanus*), northern sea robin (*Prionotus carolinus*), Atlantic tomcod (*Microgadus tomcod*), cunner (*Tautogolabrus adspersus*), rainbow smelt (*Osmerus mordax*), grubby (*Myoxocephalus aenaeus*), and longhorn sculpin (*Myoxocephalus octodecemspinosus*).

It should be noted that many of the fish species identified above are prevalent to benthic foraging, rather than pelagic and near-surface foraging. Benthic-foraging fish include the following: Atlantic sturgeon, spiny dogfish, northern sea robin, Atlantic tomcod, cunner, grubby, and longhorn sculpin. Pelagic foraging fish include Atlantic herring, Atlantic menhaden, striped bass, American shad, alewife, Atlantic silverside, weakfish, and rainbow smelt. The remaining species listed above do not limit themselves to benthic foraging, but are more likely to feed closer to the substrate rather than in the water column or near the water's surface. Because a stable fouling community will most likely not be formed until five to six years following the installation of the monopiles (Bio/consult as 2005), the above-listed fish would not be expected to forage within the wind park on a regular and predictable basis. Since Danish wind farms have not been fully constructed and in operation for over five years, the outcome of the establishment of a stable fouling community beyond five years has not yet been determined. However, once a stable fouling community is established, it is anticipated that a somewhat consistent selection of fish could also be observed foraging near the monopile foundations. Additionally, it should be noted that a majority of the fish listed are schooling fish, and that once a stable fouling community is established, that they may pass through the wind farm but they are not anticipated to aggregate around the monopile foundations as if they were reef fish, or species known to exist primarily as individuals. Schooling fish include the following: Atlantic herring, Atlantic menhaden, spiny dogfish, striped bass, American shad, alewife, inland silverside, Atlantic silverside, weakfish, and rainbow smelt (Bigelow and Schroeder 1953). At Horns Rev, individuals of species like the rock gunnel (*Pholis gunnellus*) and dragonet (*Synchiropus ocellatus*) were commonly found inhabiting the caves and crevices between the raised foundation stones (Bio/consult as 2005).

Annual post-construction/operation surveys (2003 and 2004) of the monopile communities at the Horns Rev wind farm have identified a marked succession in the number of fish species observed, which is reported to be a result of seasonal migrations of foraging fish species to the turbine sites. Schooling fish, such as cod, were observed feeding on the hard-bottom communities, while individual species, such as rock gunnel and dragonet, were commonly found inhabiting caves and crevices between foundation stones. During both the 2003 and 2004 surveys, a total of 17 different fish species were identified in the wind park (Elsam Engineering A/S and ENERGI E2 A/S 2005).

The most commonly observed fish at the Nysted wind farm during fouling community surveys included two-spotted gobi (*Coryphopterus flavescens*), goldsinny-wrasse (*Ctenolabrus rupestris*), and black goby (*Gobius niger*). Each of these species was associated with the complex hard-bottom, crevice-filled habitat provided by the raised stone and concrete scour control platforms (Birklund and Petersen 2004). If scour control mats are used to provide scour control for the monopiles in Nantucket Sound rather than rock armor, the crevice-filled rugose habitat will not be created, and as demonstrated at both the Horns Rev and Nysted wind farms, the potential for attracting benthic organisms and subsequently altering the predator-prey relationship in Nantucket Sound would be essentially zero. If rock armor backfill is used to support the Cape Wind monopile foundations, the potential to attract and harbor fish is greater, however, the likelihood that this small amount of widely spaced additional hard substrate could alter the predator-prey relationship beyond the immediate vicinity of each monopile is very small.

6.0 <u>BIRDS</u>

Based upon the fouling organisms observed and expected to establish on the monopile foundations at Horseshoe Shoal, the following species of birds may potentially forage in the wind park: red-throated loon (*Gavia stellata*), common loon (*Gavia immer*), horned grebe (*Podiceps auritus*), sooty shearwater (*Puffinus griseus*), Wilson's storm-petrel (*Oceanites oceanicus*), great cormorant (*Phalacrocorax carbo*), double-crested cormorant (*Phalacrocorax auritus*), greater scaup (*Aythya marila*), common eider (*Somateria mollissima*), seveveral species of scoters (*Melanitta spp.*), American oystercatcher (*Haematopus palliates*), redknot (*Calidris cantus*), several species of gulls (*Larus spp.*), black-legged kittiwake (*Rissa tridactyla*), and dovekie (*Alle alle*). Based upon the fish species expected to forage in the pelagic and surface areas surrounding the monopile foundations at Horseshoe Shoal, the following species of birds may potentially forage in the wind park: red-necked grebe (*Podiceps grisegena*), Northern gannet (*Morus bassanus*), long-tailed duck (*Clangula hyemalis*), osprey (*Pandion haliaetus*), ring-billed gull (*Larus delawrensis*), least tern (*Sterna antillarum*), common tern (*Sterna hirundo*), black tern (*Childonias niger*), razorbill (*Alca torda*), and Atlantic puffin (*Fratercula arctica*).

At Horns Rev, an increased avoidance of the wind farm area following the installation of the wind turbines was observed for the divers: common scoter (*Melanitta nigra)* and guillemot/razorbill (*Alca torda*). On the contrary, the herring gull (*Larus argentatus*), little gull (*Larus minutus*), and arctic/common tern displayed an increased preference for the wind farm area; and the great black-backed gull (*Larus marinus*), little gull, and arctic/common tern showed a general shift from pre-construction avoidance to post-construction preference for the wind farm area. The reason for the change in avoidance of the wind farm area for divers, common scoter, and guillemot/razorbill is unknown; however, disturbance effects from the wind turbines and disturbance from increased human activity associated with maintenance of the wind turbines are possible explanations. Denmark's National Environmental Research Institute (NERI) concluded that changes in the distribution of food resources in the study area could have potentially influenced the observed behavior, while the change in gull and tern preference for the wind farm area is likely to have been caused by the presence of the wind turbines and the associated boat activity in the area (NERI 2005a).

It is anticipated that the same behavior displayed by birds at the Horns Rev wind farm may also occur at Horseshoe Shoal. However, because a stable fouling community will most likely not be formed until five to six years following the installation of the monopiles, and pelagic and surface feeding fish would not be expected to forage within the wind park on a regular and predictable basis, it can be concluded that the above-listed birds would also not be expected to forage within the wind park on a regular and predictable basis. Once a stable fouling community is established and a somewhat consistent selection of fish could be observed foraging on the fouling community, it could also be assumed that a consistent selection of birds (including the ring-billed, herring, and great black-backed gulls and the common tern) would also have a tendency to feed within the wind park.

7.0 MARINE MAMMALS

7.1 Seals

The diets of the harbor seal (*Phoca vitulina concolor*) and gray seal (*Halichoerus grypus*) depend on the availability and abundance of fish and invertebrate species. Harbor seals forage on invertebrates and a variety of available fish species including: Atlantic herring, squid, alewife, flounder, hake, sand lance, and mackerel (Katona *et al.,* 1993). Gray seals have an extensive fish diet that consists of lampsuckers, pollock, conger eel, skates, rays, wrasse, whiting, Atlantic herring, cod, flounder, squid, mackerel, capelin, lumpfish, silver hake, and sand lance (Katona *et al.,* 1993). The waters of Nantucket Sound and the surrounding areas support large populations of these fish species. However, based upon the macroinvertebrate species observed on the pilings of the Cape Wind meteorological tower and the additional fouling species known to be common in the Project area, from the aforementioned seal-preferred prey fish, only Atlantic herring and alewife are anticipated to forage within the wind farm. Therefore, it is unlikely that gray and harbor seals will be specifically attracted to the wind farm for foraging purposes.

Seal activity in the Horns Rev wind farm was monitored during post-construction/operation surveys conducted annually between 2002 and 2004. Using satellite transmitters, 10 seals were tagged and their location and activities were recorded. In 2002, survey results indicated that the Horns Rev wind farm existed within a central corridor that seals traveled between foraging areas and haul out grounds. The area of the wind farm itself seemed to be of lesser importance for foraging, as the seals reportedly spent less than 1% of the recorded time in the wind farm. The tagged seals spent the majority of time foraging in other areas of the North Sea. Following the initial survey in 2002 it was concluded that the wind farm was an unlikely restriction on the seals' foraging activities. Due to a combination of technical difficulties and taking into account the previous year's results, the 2003 survey was suspended with the explanation that the Horns Rev wind farm area was only of minor importance to the seals' activities. The survey was resumed in 2004, but results will not be disclosed until reports are published in 2006 (Elsam Engineering A/S and ENERGI E2 A/S 2005).

Seal activity in the Nysted wind farm was monitored before construction (2002) to establish baseline data, during construction (2003) to monitor the seals' behavior in response to the activity, and post-construction/operation (2004) to monitor the seals' behavior in response to the existence of the wind farm. Each annual survey consisted of three monitoring components: aerial surveys, remote video registration, and satellite tagging. Baseline aerial surveys confirmed that a seal sanctuary exists approximately 4 kilometers (km) east of the Nysted wind farm area. Due to a seal epidemic (Phocine Distemper Virus, PDV) that depleted the seal population in 2002 by approximately 44%, a population of approximately 200 seals was recorded. The 2003 aerial survey found that despite wind farm construction activities, the depleted seal population rebounded by approximately 15%; therefore, increasing to approximately 230 individuals. The population was observed to have increased an additional 42% by the time the 2004 aerial survey was conducted. It appeared that not only had breeding taken place, but a number of individuals emigrated from surrounding sanctuaries. While there is no evidence that the seals were attracted to the vicinity of the wind farm for any particular reason, the observations clearly demonstrate that the seals were not deterred from the presence of the operating monopiles.

It was anticipated that the remote video registration and satellite tagging programs would provide more insight as to whether or not the seals are specifically attracted to the wind farm to forage (Elsam Engineering A/S and ENERGI E2 A/S 2005). Remote video registration required the installation of two towers, each equipped with visible light video cameras, approximately 600 m from the seal's preferred haul out site. The objective of the video cameras was to monitor the temporary and permanent effects of the wind farm's construction and presence on the seals' behavior. Baseline observations reported that a greater population of seals used the haul out site in the spring and summer, rather than in the winter. In the following year (2003), despite the ongoing wind farm construction activities, the video recorded the seals exhibiting the same seasonal patterns as observed during the baseline year. Video recorded in 2004 captured images of gray and harbor seal pups at the haul out sites, which marked the first time in decades that a gray seal bred in Danish waters. Following the review of the 2004 video data, it was concluded that the construction and operation of the wind farm had little to no negative effect on the presence of nearby, hauled out seals (Elsam Engineering A/S and ENERGI E2 A/S 2005).

Satellite transmitter monitoring of the seal activity in the Nysted wind farm was conducted in similar fashion to that of the Horns Rev wind farm. Ten seals (four harbor seals and six gray seals) were tagged with satellite transmitters for the purpose of tracking their home range and migration patterns to determine the vulnerability of the species to the wind farm's construction and operation. In 2002, baseline survey results indicated that the vicinity of the Nysted wind farm is also the home range for an estimated 95% of the local harbor seal population, but is of minor importance to the gray seal. The 2003 survey for Nysted was also suspended due to technical difficulties and limited time and resources. It is not reported whether or not the survey was resumed in 2004 (Elsam Engineering A/S and ENERGI E2 A/S 2005).

It is anticipated that the same behavior displayed by seals at the Danish wind farms may also occur at Horseshoe Shoal. While limited information exists regarding the invertebrate and fish species that are preyed on by seals in Danish waters, the available information regarding their reactions to the wind farms' construction and operation provides insight as to seal behavior that can be anticipated in the vicinity of Cape Wind's proposed wind farm. The Danish wind farms' construction and operation did not in any way permanently affect the natural behaviors of the local seal population. Despite the construction of the Nysted wind farm, the PDV-induced depleted seal population was able to recover, and gray seals resumed breeding in Danish waters.

Additionally, taking into consideration that Atlantic herring and alewife, both of which are migrating fish species and therefore are not likely to aggregate within the wind farm, are the only seal-preferred prey anticipated to potentially forage within Cape Wind's proposed wind farm, it is unlikely that gray and harbor seals will be attracted to the wind farm to forage. Therefore, it is expected that seals in Nantucket Sound will not be negatively affected by the construction or operation of the proposed wind farm, and will most likely continue to behave according to their current foraging, migration, and breeding patterns.

7.2 Dolphins & Porpoises

Three dolphin species and one porpoise species have the potential to occur in Nantucket Sound: the white-sided dolphin (*Lagenorhynchus acutus*), striped dolphin (*Stenella coeruleoalba*), common dolphin (*Delphinus delphis*), and harbor porpoise (*Phocoena phocoena*). Each of the four species feed on a variety of different invertebrate and fish species that include the following: cephalopods, crustaceans, shrimp, smelt, hake, Atlantic herring, cod, tuna, anchovy, bonito, and pollock (Masi 2000; Savage 2000; Alspaugh 2000; Kopack 2000). The waters of Nantucket Sound and the surrounding areas support large populations of these fish species. However, similar to those fish species on which seals are likely to prey, based upon the macroinvertebrate species observed on the pilings of the Cape Wind meteorological tower and the additional fouling species known to be common in the Project area, Atlantic herring is the only dolphin and porpoise-preferred prey that is anticipated to forage within the wind farm. Therefore, it is unlikely that the dolphin and porpoise species will be strongly attracted to the wind farm to forage.

Harbor porpoise activity in the Horns Rev wind farm was monitored annually prior to (2001), during (2002), and following (2003-2004) construction activities. During each of the annual surveys, a combination of visual observations and acoustic porpoise detectors (PODs) were used to record the porpoise activity in and around the area of the wind farm. For baseline surveys conducted in 2001, eight PODs were stationed at various locations in the area where the Horns Rev wind farm was to be constructed (Elsam Engineering A/S and ENERGI E2 A/S 2005). PODs record echolocation clicks from porpoises or any other echolocating cetacean species that may pass through the area (NERI 2002). Baseline survey results indicated that dense porpoise populations existed in the waters northwest of the wind farm area, while only few porpoises were observed or recorded in the immediate wind farm area (Elsam Engineering A/S and ENERGI E2 A/S 2005).

Deterrents such as pingers and scaring devices were used during the construction to prevent porpoises from entering within a range that could potentially cause permanent damage to their echolocation abilities. Construction monitoring (2002) survey results indicated that deterrent devices were successful; however, porpoises were observed returning to the wind farm area within three to four hours after pile driving ceased. Therefore, as anticipated and desired prior to the start of construction, porpoise activity in the Horns Rev wind farm decreased during construction (Elsam Engineering A/S and ENERGI E2 A/S 2005).

Horns Rev operation (2003-2004) survey results indicated porpoise activity returned to levels comparable to that recorded during the 2001 baseline survey. Following construction, POD recordings indicated that echolocation within the wind farm was slightly lower than baseline levels. It is believed that there is not currently enough data to draw final conclusions regarding the effects of the wind farm on porpoise activity (Elsam Engineering A/S and ENERGI E2 A/S 2005). However, based upon post-construction/operation survey results, it is clear that the existence of the Horns Rev wind farm, and its macrofouling and fish species, do not specifically attract foraging porpoises.

Harbor porpoise activity in the Nysted wind farm was monitored in a similar manner to that at the Horns Rev wind farm. Baseline observations of porpoises in and around the Nysted wind farm were gathered. Prior to construction, satellite tracking of 60 porpoises in Danish waters found that some of the tracked animals regularly pass through the Nysted wind farm area, but did not remain in the area for extended durations (NERI 2003). PODs were used to measure porpoise activity during construction (2001-2003) and in the post-construction/operation phase (2003-2004) (Elsam Engineering A/S and ENERGI E2 A/S 2005).

Acoustic deterrents, or pingers, were also used during the construction of the Nysted wind farm to prevent porpoises from entering within a range that could potentially cause permanent echolocation damage. Construction monitoring (2001-2003) survey results indicated that deterrent devices were successful, and coupled with construction, the deterrents were deemed responsible for the significant temporary decrease of porpoise activity near the Nysted wind farm. As construction progressed, the average waiting time, or the duration of time after temporary cessation of construction that it took for the return of porpoises to the area, increased from approximately eight hours to approximately 64 hours (Elsam Engineering A/S and ENERGI E2 A/S 2005).

Nysted operation (2003-2004) survey results indicated that in the first year of operation, relative to porpoise abundance observed and recorded during construction activities, there was no significant increase in porpoise abundance. However, when porpoises were present in the wind farm, POD recordings of echolocation activity were comparable to preconstruction levels. Similar to research at Horns Rev, it is believed that there is not currently enough data to draw final conclusions regarding the effects of the Nysted wind farm on porpoise activity (Elsam Engineering A/S and ENERGI E2 A/S 2005).

It is anticipated that the same behavior displayed by harbor porpoises at the Danish wind farms may also be displayed at Horseshoe Shoal by the three dolphin species (white-sided dolphin, striped, and common) and the harbor porpoise. While limited information exists regarding the feeding behavior and prey species of the harbor porpoise in Danish waters, the available information regarding their behavioral reactions to the wind farms' construction and operation provides insight as to dolphin and porpoise behavior that should be anticipated in the vicinity of Cape Wind's proposed wind farm. Elsam Engineering A/S and ENERGI E2 A/S (2005) loosely concluded that the Danish wind farms' construction and operation did not in any way permanently affect the natural behavior of the local harbor porpoise population. Despite the reduction of porpoise abundance following the construction of the Nysted wind farm, the porpoise activity levels, when present in the wind farm resumed pre-construction levels.

Additionally, taking into consideration that based on the macrofouling communities anticipated to develop, Atlantic herring is the only dolphin and porpoise-preferred prey anticipated to forage within Cape Wind's proposed wind farm, it is unlikely that dolphin and porpoise species will be attracted to the wind farm to forage. Therefore, it is expected that dolphin and porpoise populations in Nantucket Sound will not be negatively affected by the construction or operation of the proposed wind farm, and will most likely continue to behave according to their current foraging, migration, and breeding patterns without being specifically attracted to the wind farm.

7.3 Whales

While documented sightings are infrequent, five whale species do have the potential to occur in Nantucket Sound: the North Atlantic right whale (*Eubalaena glacialis*), humpback whale (*Megaptera novaeangliae*), fin whale (*Balaenoptera physalus*), long-finned pilot whale (*Globicephala melas*), and minke whale (*Balaenoptera acutorostrata*).

The primary prey of right whales in the western North Atlantic are calanoid copepods and juvenile euphausiids (Nemoto 1970; Watkins and Schevill 1979; Kraus and Prescott 1982; Murison and Gaskin 1989). Right whales traditionally filter feed at depth, but occasionally skim feed at the water's surface (Nemoto 1970). They have been observed feeding in Cape Cod Bay, Stellwagen Bank (Watkins and Schevill 1979; Payne and Heinemann 1990), the Great South Channel (CeTAP 1982; Winn *et al.* 1995), Jeffreys Ledge, the lower Bay of Fundy (Kraus *et al.* 1986; Gaskin 1982), and the Scotian Shelf (Brownell *et al.* 1986; NMFS 2005), and are likely to migrate to other areas where planktonic conditions are suitable.

Humpback whales feed opportunistically on a wide variety of species of pelagic crustaceans (Nemoto 1970; Kreiger and Wing 1984), sand lance, (Hain *et al*. 1982; Payne *et al*. 1986, 1990), capelin, euphausiids (Whitehead and Glass 1985; Kenney and Winn 1986), herring, mackerel, menhaden, pollock, small haddock, and squid (Overholtz and Nicolas 1979; Meyer *et al.* 1979; Whitehead and Glass 1985; Whitehead 1987; Piatt *et al*. 1989; NMFS 1991). Humpbacks feed on schools of fish, and traditionally lunge-feed (Hain *et al*. 1982; Würsig 1990), but may also use a variety of herding strategies that include bubble clouding (Hain *et al*. 1982) and bottom feeding (Hain 1991). Humpback whales have been observed feeding at Stellwagen Bank (Payne *et al*. 1986, 1990; Waring et al. 2001), Georges Bank, the Cultivator Shoals, and Jeffreys Ledge (Blaylock *et al*. 1995).

Fin whales feed on a wide variety of crustaceans and small schooling fish including sand lance (Overholtz and Nicolas 1979; McKenzie and Nicolas 1988), capelin (Piatt *et al*. 1989), euphausiids and myctophid fish when locally abundant; copepods, and squid (Mitchell 1974; Katona *et al*. 1977). The feeding behaviors of fin whales are similar to that of humpbacks, and both species are frequently seen feeding together (CeTAP 1982). Fin whales have been observed feeding throughout the Gulf of

Maine, specifically at Stellwagen Bank (Overholtz and Nicolas 1979; McKenzie and Nicolas 1988) and in the coastal waters of Newfoundland (Piatt *et al*. 1989) and Nova Scotia (Brodie *et al*. 1978).

Long-finned pilot whales primarily feed on squid, and feed on the following fish when available: cod, mackerel, hake, halibut, eelpout, sand lance, goby, haddock, herring, and spiny dogfish (Kuo 1999; ACS 2004a; OBIS-SEAMAP 2002a). In the western North Atlantic, long-finned pilot whales have been observed along the continental shelf and coast of North America including the coast of Newfoundland, Georges Bank, and the Gulf of Maine (OBIS-SEAMAP 2002a).

Minke whales primarily feed on a variety of crustaceans and fish including krill, squid, capelin, cod, herring, pollock, sand lance, and haddock (Fahey 1999; ACS 2004b; OBIS-SEAMAP 2002b). The range of the minke whale population extends south from Canada to the Gulf of Mexico, but its distribution is primarily concentrated in New England waters, with most sightings occurring during spring and summer months (Waring et al., 2001).

The following whale species are likely to occur in Danish waters: minke whale, fin whale, sperm whale (*Physeter macrocephalus*), and long-finned pilot whale (Ministry of the Environment 2003). While research and monitoring at Denmark's Horns Rev and Nysted wind farms specifically assessed the affects of the wind farms on local seal and porpoise populations, the research did not specifically assess the likelihood of whales to avoid or approach the wind farm based on its existence, or the availability of prey species.

In general, the waters of Nantucket Sound and the surrounding area support populations of the various plankton and fish species on which the right, humpback, fin, long-finned pilot, and minke whales prey. Similar to the feeding patterns discussed in regards to seals, dolphins, and porpoises, based upon the macroinvertebrate species observed on the pilings of the Cape Wind meteorological tower and the additional fouling species known to be common in the Project area, Atlantic herring, menhaden, and spiny dogfish are the whale-preferred prey that are anticipated to potentially forage within the wind farm. However, Atlantic herring, menhaden, and spiny dogfish are traditionally schooling species (Bigelow and Schroeder 1953). At Horns Rev, individuals of species like the rock gunnel (*Pholis gunnellus*) and dragonet (*Synchiropus ocellatus*), rather than schools of fish, were commonly found inhabiting the caves and crevices between the raised foundation stones (Bio/consult as 2005). Therefore, it is expected that despite the readily available food resource, most schooling fish would tend not to aggregate at the base of the monopiles. It is more likely that if the three species of fish exist as schools within the proposed wind farm, that they would more likely be migrating through the wind farm rather than aggregated. Therefore, because the schooling fish species are not anticipated to be permanent inhabitants within the wind farm, the whales are also not anticipated to be attracted to forage within the proposed wind farm.

Most whales are found in areas where their primary food source can be easily located. The primary feeding grounds for many whales are located further offshore from Nantucket Sound at Stellwagen Bank, in Cape Cod Bay, and in the Gulf of Maine. The bathymetric and oceanographic features that favor dense aggregations of whale prey species are not developed in Nantucket Sound to the same extent that they are farther north, around Stellwagen Bank, Jeffreys Ledge, Browns and Bacaro

Banks, and in the Great South Channel (Kenney and Winn, 1986). Historically and at present, Nantucket Sound does not appear to be an important area for these species of whales.

8.0 CONCLUSION

While a common ecological correlation between hard-bottom habitat communities, fish, and birds has to some extent been observed at the Danish wind farms, this is not likely to translate to the proposed Nantucket Sound wind farm based on the available data. The primary basis for this conclusion is that the Nantucket Sound wind farm proposes to use scour control mats to minimize the potential for colonization by benthic organisms and fish and will therefore be less likely to attract birds. If rock armoring is necessary, the amount of material being added at the base of each monopile and the placement of the rock armor flush with the surrounding substrate will be relatively insignificant in relation to the amount of hard-bottom substrate already scattered throughout Nantucket Sound. Although there might be a localized affect in the immediate vicinity of each monopile if rock is used, the impact to the existing predator-prey relationship in Nantucket Sound is expected to be negligible.

Information available regarding the reactions of seals and porpoises to the Danish wind farms' construction and operation provides insight as to the seal, dolphin, and porpoise behavior that can be anticipated in the vicinity of Cape Wind's proposed wind farm. The Danish wind farms' construction and operation did not in any way permanently affect the natural behaviors of the local seal and porpoise populations; likewise, it is expected that seal, dolphin, and porpoise populations in Nantucket Sound will not be negatively affected by the construction or operation of the proposed wind farm, and will most likely continue to behave according to their current foraging, migration, and breeding patterns without being specifically attracted to the wind farm. Additionally, because the schooling fish species are not anticipated to be permanent inhabitants within the wind farm, and Nantucket Sound does not appear to be an important area for these species of whales, the five whale species are also not anticipated to be attracted to forage within the proposed wind farm

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Figures

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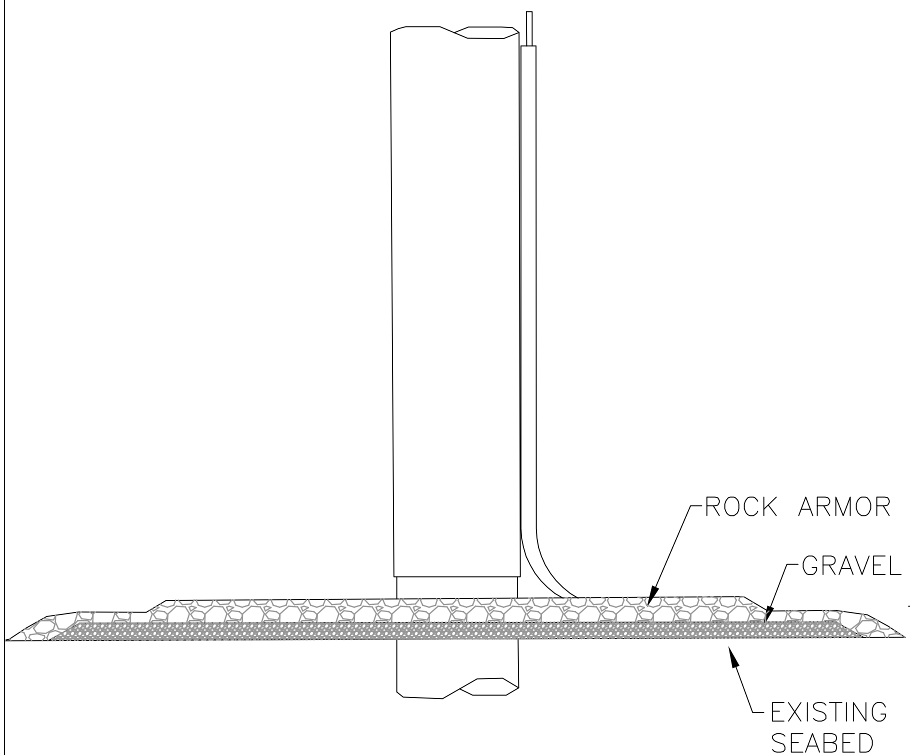

HORNS REV MONOPILE STRUCTURE

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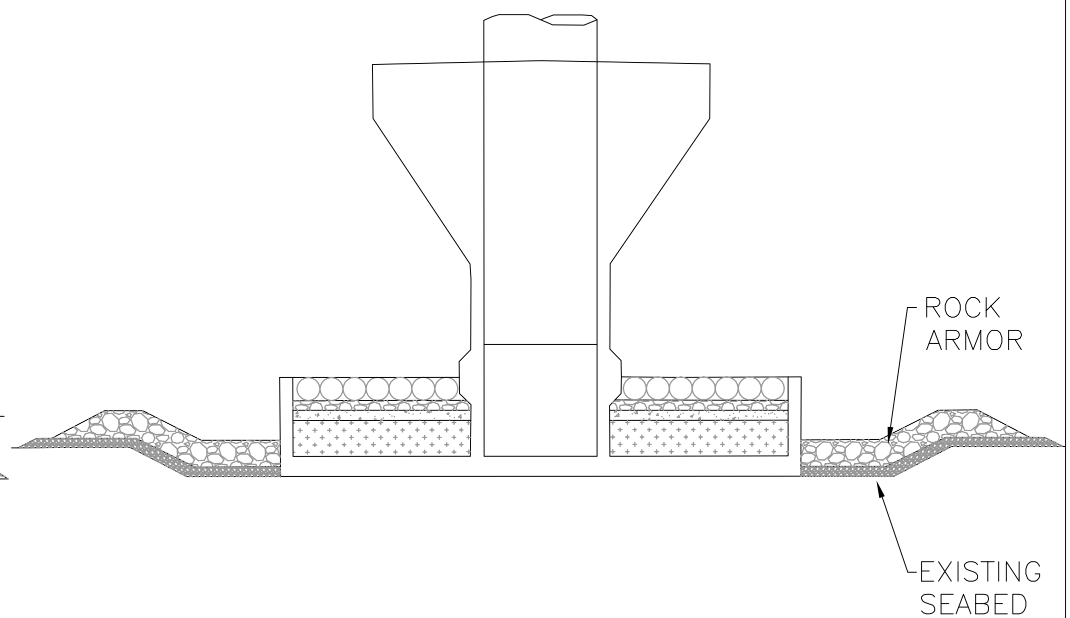

NYSTED GRAVITY FOUNDATION

NOT TO SCALE

ESS Group, Inc.
Engineers
Scientists
Consultants

Horns Rev and Nysted Wind Parks - Monopile Foundations

Sources: Bio/Consult as 2005; Birklund and Peterson 2004

Figure 1

Tables

Table 1. Macroinvertebrate Sampling Data at the Meteorological Tower, Nantucket Sound (6/3/2005).

Taxa	Number of Individuals per m2		
	T3B	T2M	T1S
Bivalvia			
Mytilus edulis	24	28	12
Crustacea			
Amphipoda			
Ampeliscidae	4		
Caprella penantis	12	12	148
Corophiidae	560	144	40
Photidae	544	292	1100
Cirripedia			
Balanus sp.	84	40	8
Decapoda			
Panopeus herbstii	4	4	
Unidentified crab larvae		24	68
Entoprocta	8		
Gastropoda			
Crepidula plana	4		
Crepidula fornicata			
Mitrella lunata	8		
Sacoglossa			4
Urosalpinx cinerea	4		
Nematoda	76	4	
Nemertea	16		
Polychaeta			
Glycera spp.		4	
Harmothoe sp.	16		
Lepidonotus sp.	4	16	4
Paronidae	12		
Phyllodocidae	4		
Polydora spp.	16		
Potamilla reniformis	4		
Syllidae	44	4	
Porifera			
Scypha ciliata			4
Pycnogonida			
Tanystylum orbiculare	8	12	
Turbellaria	8		
Total	**1464**	**584**	**1388**
Number of Taxa	**22**	**12**	**9**