UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
NORTHEAST REGION
55 Great Republic Drive
Gloucester, MA 01930-2276

OCT 10 2012

Amy Hull, Acting Chief
Environmental Review and Guidance Update Branch
Division of License Renewal
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Re: Seabrook Station Relicensing

Dear Ms. Hull,

Your December 29, 2011, letter requests consultation pursuant to Section 7 of the Endangered Species Act (ESA) of 1973, as amended regarding the Nuclear Regulatory Commission's (NRC) proposed relicensing of Seabrook Station Unit 1. Seabrook Station is located in the Town of Seabrook, Rockingham County, New Hampshire and is operated by NextEra Energy Seabrook, LLC (NextEra). You have made the preliminary determination that the continued operation of Seabrook under the terms of a renewed license is not likely to adversely affect any species listed by NOAA's National Marine Fisheries Service (NMFS) and have requested our concurrence with your determination. Your assessment of effects of the project on listed species is included in the Draft Supplemental Environmental Impact Statement [NUREG 1437 Supplement 46] dated July 2011. Since the time consultation was requested, we have requested information from the U.S. Environmental Protection Agency (EPA) regarding their plans to reissue a National Pollutant Discharge Elimination System (NPDES) permit for this facility. However, EPA has stated that they currently have no schedule for permit reissuance. Therefore, despite our efforts to obtain updated information from EPA, we consider the effects of future operations of Seabrook in compliance with the existing NPDES permit (see below).

A "not likely to adversely affect" determination can only be made when effects on listed species are expected to be beneficial; or adverse effects are expected to be discountable and/or insignificant. As explained in the joint U.S. Fish and Wildlife and NMFS Section 7 Handbook, "beneficial effects are contemporaneous positive effects without any adverse effects. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Discountable effects are those extremely unlikely to occur. Based on best judgment, a person would not: (1) be able to meaningfully measure, detect, or evaluate insignificant effects; or (2) expect discountable effects to occur." We concur with your determination. We outline the justification for our determination below.

Description of the Facility and Proposed Action

You are proposing to issue a renewed Operating License for the Seabrook facility. The facility is owned and operated by NextEra. The plant was originally licensed in 1990, and the current license expires March 15, 2030. NextEra has submitted an early renewal application. If issued, the renewed license would become effective on the issuance date, would replace any remaining term of the original license and would authorize an additional twenty-year period. Under the terms of a new license, the facility could operate until March 15, 2050. There would be no major construction, refurbishment or replacement activities associated with the license renewal. If the NRC approves the license renewal application, the reactor and support facilities would be expected to continue to operate and be maintained until the renewed license expires in 2050.

Seabrook is a single unit, pressurized-water reactor plant. Seabrook employs a once-through heat dissipation system designed to remove waste heat from the plant. Seabrook withdraws water from and discharges water to, the Atlantic Ocean, with intakes and outfalls located approximately 1 mile off the New Hampshire coast. The circulating water system provides cooling water to the main condensers to remove the heat that is rejected by the turbine cycle and auxiliary system and to the plant's service water system. Water for this system is carried to and from the Atlantic Ocean to the plant through long tunnels drilled through the underlying bedrock. The tunnels are hydraulically connected to the ocean by way of concrete shafts that extend approximately 6,000 feet offshore, with the intake and discharge points approximately 60 feet below sea level. A complete description of the facility and its operation is included in the DSEIS (NRC 2011).

In 1972, Congress assigned authority to administer the Clean Water Act (CWA) to the U.S. Environmental Protection Agency (EPA). EPA issues National Pollutant Discharge Elimination System (NPDES) permits for facilities in New Hampshire. Section 316(b) of the CWA requires that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available (BTA) for minimizing adverse environmental impacts (33 USC 1326). EPA regulates impingement and entrainment under Section 316(b) of the CWA through the NPDES permit process. The EPA administers Section 316(b) in New Hampshire through the NPDES program.

Seabrook cannot operate without the intake and discharge of cooling water. NRC is responsible for authorizing the operation of nuclear facilities, as well as approving any extension of an initial operating license through the license renewal process. Intake and discharge of water through the cooling water system would not occur but for the operation of the facility pursuant to a renewed license; therefore, the effects of the cooling water system on listed species and any designated critical habitat are effects of the proposed action.

Pursuant to NRC's regulations, operating licenses are conditioned upon compliance with all applicable law, including but not limited to CWA Section 401 Certifications and NPDES permits. Therefore, the effects of the proposed Federal action-- the continued operation of Seabrook as proposed to be approved by NRC, which necessarily involves the removal and discharge of water from the Atlantic Ocean-- are shaped not only by the terms of the renewed operating license but also by the NPDES permit issued. In this consultation, we consider the effects of the operation of Seabrook pursuant to the extended Operating License to be issued by the NRC and the NPDES permit issued by EPA that is already in effect; this is the scenario contemplated in the DSEIS. The NPDES permit for this facility was last issued in 2002. This permit expired in 2007 and has been administratively extended each year. We requested information from EPA Region 1 regarding the expected publication date for a revised draft permit and were told that no schedule is currently available. Based on this, we do not anticipate that a revised NPDES permit will be available prior to the scheduled issuance of the FSEIS (April 2013), after which NRC would make a licensing decision. As such, we have considered the effects of continued operation of Seabrook under the terms of a new operating license and the existing 2002 NPDES permit (EPA 2002).

NMFS Listed Species in the Action Area
The action area is defined as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action" (50CFR§402.02). The Seabrook facility is located on land. The effects analysis presented below will be limited to effects experienced in the aquatic environment. Effects of this action on listed species include impingement and entrainment of potential prey and effects to habitat, including the discharge of heated effluent. Therefore, the action area for this consultation includes the intake area and the region within the Gulf of Maine where effects of the thermal plume are experienced. At the surface, the thermal plume has dissipated at a distance of 500 meters. At the bottom, measurements have not been made to determine the exact distance at which the plume is no longer detectable; however, at a distance of 5 miles from the outfall, there are no differences in temperature from ambient. As we explain below, all direct and indirect effects to listed species are limited to the area where increased water temperatures are experienced; thus, the action area is also limited to this area.

North Atlantic right whales (*Eubalaena glacialis*) occur off the New England coast nearly year round. The species population size was estimated to be at least 361 individuals in 2005 based on a census of individual whales identified using photo-identification techniques (Waring *et al.* 2010). The population trend for right whales is increasing; the mean growth rate for the population from 1990-2005 was 2.1% (Waring *et al.* 2010). Of the 17,257 right whale sightings in New England during 1970 through 2005, none were in the action area (Pace and Merrick 2008). Sightings from May 1997 to the present have been mapped (see http://www.nefsc.noaa.gov/psb/surveys/SASInteractive2.html. Since 1997, there have been no sightings of right whales within 10 miles of the Seabrook outfall/intake. The seasonal presence of right whales in New England waters is thought to be closely associated to the seasonal presence of dense patches of their preferred copepod prey (primarily *Calanus finmarchus* but also *Pseudocalanus* spp. and *Centropages* spp.; Pace and Merrick 2008). The action area is outside of the "foraging region" for this species as identified in Pace and Merrick 2008. We also reviewed sightings data from the Atlantic Marine Assessment Program for Protected Species (AMAPPS) surveys carried out in 2011 (NEFSC and SEFSC 2012). AMAPPS is a comprehensive research program to assess the abundance and spatial distribution of marine mammals, sea turtles, and sea birds in US waters of the western North Atlantic Ocean. No sightings of right whales were observed in the action area.

Humpback whales (*Megaptera novaeangliae*) feed during the spring, summer, and fall over a range that encompasses the eastern coast of the United States. Humpback whales in this area belong to the Gulf of Maine stock. The humpback whale population is thought to be steadily increasing and numbers over 11,000 individuals (Waring *et al.* 2010). While small numbers of humpback whales may be present off the New England coast year round, sightings are most frequent from mid-March through November between 41°N and 43°N, from the Great South Channel north along the outside of Cape Cod to Stellwagen Bank and Jeffreys Ledge (CETAP 1982) and peak in May and August (Waring *et al.* 2010). We have reviewed sightings data plotted in the OBIS-SEAMAP[1] database and in the 2011 AMAPPS report. There are no occurrences of humpback whales recorded in the action area and only three sightings of humpback whales within 10 miles of the Seabrook intake/outfall (September 1978, August 1979 and November 2004).

Fin whales (*Balaenoptera physalus*) are also known to be present in the Gulf of Maine and could occur in the action area. The best abundance estimate available for the western North Atlantic fin whale stock is 3,985 (CV=0.24) (Waring *et al.* 2010). We have reviewed sightings data plotted in the OBIS-SEAMAP database. This database contains records of 61,874 individual sightings of fin whales; none are in the action area, with the nearest sighting being just further than 5 miles from the intake/outfall (three animals sighted in August 1980). There were no fin whales observed in the action area by the 2011 AMAPPS survey.

NRC's BA and DSEIS also discuss sei and sperm whales. Sei (*Balaenoptera borealis*) whales occur in deep water throughout their range, typically over the continental slope or in basins situated between banks (NMFS 2011). Sperm whales (*Physter macrocephalus*) occur on the continental shelf edge, over the continental slope, and into mid-ocean regions. There are no recorded sightings of sei or sperm whales in the action area in the OBIS-SEAMAP database or during the 2011 AMAPS surveys.

Certain New England waters were designated as critical habitat for Northern right whales[2] in 1994 (59 FR 28793). The Great South Channel critical habitat is the area bounded by 41°40′ N/69°45′ W; 41°00′ N/69°05′ W; 41°38′ W; and 42°10′ N/68°31′ W. The Cape Cod Bay critical habitat is the area bounded by 42°02.8′ N/70°10′ W; 42°12′ N/70°15′ W; 42°12′ N/70°30′ W; 41°46.8′ N/70°30′ W and on the south and east by the interior shore line of Cape Cod, Massachusetts. The maximum distance that the thermal plume extends from the Seabrook outfall is approximately 60 miles from the area in Cape Cod Bay designated as critical habitat and even further from the Great South Channel critical habitat area.

Sea turtles are seasonally present off the New England coast. The species that may occur in the action area include the threatened Northwest Atlantic Distinct Population Segment (DPS) of loggerhead (*Caretta caretta*) sea turtles as well as endangered Kemp's ridley (*Lepidochelys*

---

[1] Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations is a spatially referenced online database aggregating marine mammal, seabird and sea turtle observation data from across the globe. The maps illustrate sightings from 432 databases. Available at: www.seamap.env.duke.edu (last accessed May 10, 2012).

[2] In 2008, NMFS listed the endangered northern right whale (*Eubalaena spp.*) as two separate, endangered species: the North Pacific right whale (*E. japonica*) and North Atlantic right whale (*E. glacialis*) (*73 FR 12024*). We received a petition to revise the 1994 critical habitat designation in October 2009. In an October 2010 *Federal Register* notice, we announced that we intend to revise existing critical habitat by continuing our ongoing rulemaking process to designate critical habitat for North Atlantic right whales with the expectation that a proposed critical habitat rule for the North Atlantic right whale will be published in 2011. To date, we have not published a proposed rule so the 1994 critical habitat designation for northern right whales is the only critical habitat for right whales in the Atlantic.

kempi) sea turtles, endangered leatherback sea turtles (*Dermochelys coriacea*) and endangered green sea turtles *(Chelonia mydas). Generally, se*a turtles are uncommon in waters north of Cape Cod Bay, with sightings limited to occasional loggerhead or leatherback sea turtles. There are no recorded sightings of sea turtles in the action area in the OBIS-SEAMAP, CeTAP or AMAPPS databases. Several studies have examined the seasonal distribution of sea turtles in northeast waters. Sea turtles undergo directed seasonal movements between southern and northern Atlantic coastal habitats. These seasonal movements include a directed movement south in the fall and a return to northern foraging areas in the spring. The southward migration in the fall is thought to be triggered by the abrupt water temperature change that occurs in October, which causes sea turtles to depart northern inshore habitats and begin a southern migration in the open ocean. Tracking studies summarized in Morreale and Standora (2005) indicate that sea turtles would begin leaving New Hampshire waters in October and generally, by the first week of November turtles are located south of the Virginia border. As water temperatures warm in the spring, sea turtles begin to move northward, with sea turtles arriving in New England in June (summarized in Morreale and Standora, 2005). Based on the available information, very few sea turtles are likely to occur in the action area. These occurrences would be limited to loggerhead and leatherback sea turtles between June and October.

On February 6, 2012, we published two rules listing five DPSs of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) under the ESA. The effective date of these listing rules was April 6, 2012. The marine range of all five DPSs extends along the Atlantic coast from Canada to Cape Canaveral, Florida. Atlantic sturgeon originating from any of five DPSs could occur in Cape Cod Bay and may be present in the action area. Atlantic sturgeon originating from the New York Bight, Chesapeake Bay, South Atlantic and Carolina DPSs are listed as endangered. Atlantic sturgeon originating from the Gulf of Maine DPS are listed as threatened. Atlantic sturgeon spawn in their natal river and remain in the river until approximately age two and at lengths of approximately 76-92 cm (30-36 inches; ASSRT 2007). After emigration from the natal estuary, subadult and adult Atlantic sturgeon forage within the marine environment, typically in waters less than 50 m in depth, using coastal bays, sounds, and ocean waters (see ASSRT 2007). The nearest rivers to Seabrook where Atlantic sturgeon are known to spawn are the Kennebec River (Maine) and the Hudson River (New York). Because of the distance from the nearest known spawning grounds and the intolerance of early life stages and juveniles to saline waters, no eggs, larvae or juvenile Atlantic sturgeon are likely to occur in the action area. Only sub-adult or adult Atlantic sturgeon would be present in the action area. Atlantic sturgeon in the action area are likely to be migrating and could also be foraging opportunistically. We do not have any estimates of the number of Atlantic sturgeon present in the action area specifically. NRC reports that gill-net monitoring studies in the vicinity of Seabrook's intakes and outfalls have only captured one Atlantic sturgeon. These studies took place between 1976 and 1997.

Shortnose sturgeon (*Acipenser brevirostrum*) are listed as endangered throughout their range. There are no rivers in New Hampshire that are known to support shortnose sturgeon populations. Shortnose sturgeon do occur in the Merrimack River (Massachusetts) and several rivers in Maine. Recent tagging and telemetry studies have documented the movement of individual shortnose sturgeon between the Merrimack River and the Kennebec River (Maine). We have very limited information on the oceanic movements of this species; however, we assume that movements occur in near shore areas. The detection of migratory shortnose sturgeon in small coastal rivers supports this assumption. It is possible that occasional shortnose sturgeon occur in the action area; however, any occurrence of shortnose sturgeon is likely to be rare and limited to transient individuals moving along the coast. No shortnose sturgeon have been documented in New Hampshire waters since 1971.

Effects of the Action

Below we consider the effects to listed species of the continued operation of Seabrook under the terms of a new operating license on listed species. We consider the effects of water withdrawal (impingement or entrainment of individuals and their prey) and effects of the discharge of effluent (exposure to pollutants, including heat, and effects on prey).

Entrainment of Listed Species

Entrainment occurs when small aquatic life forms are carried into and through the cooling system during water withdrawals. Entrainment primarily affects organisms with limited swimming ability that can pass through the screen mesh, used on the intake systems.

Entrainment studies have taken place since 1990. To be entrained in the facility an organism must be able to pass through the 3/8" mesh. All whales, sea turtles, and Atlantic sturgeon are considerably larger than this minimum size, making entrainment impossible. Because of this, no entrainment of listed species will occur during the period of continued operations.

Impingement of Listed Species

Impingement occurs when organisms are trapped against cooling water intake screens or racks by the force of moving water. Impingement happens when aquatic species cannot escape from the screen or rack and become stuck. The intake tunnels are equipped with vertical bars spaced 5" apart. There is also a 3/8" mesh traveling screen system. Impingement studies have taken place since 1995.

Atlantic and shortnose sturgeon

Fish that are narrower than 5-inches may pass through the trash bars and become impinged on the traveling screens. Fish with body widths larger than 5-inches could become impinged on the trash racks. Nearly all shortnose sturgeon in the action area would be narrower than 5 inches. Some subadult Atlantic sturgeon may also be narrow enough to pass through the trash bars.

Regardless of fish size, impingement only occurs when a fish cannot swim fast enough to escape the intake (e.g., the fish's swimming ability is overtaken by the velocity of water being sucked into the intake). Intake velocities at Seabrook's racks are approximately 1.0 feet per second (fps) or less (NRC 2010). In order for impingement to happen, a fish must be overcome by the intake velocity. Juvenile and adult shortnose sturgeon (body lengths greater than 58.1cm) have been demonstrated to avoid impingement and entrainment at intakes with velocities as high as 3.0 feet per second (Kynard *et al.* 2005). Assuming that Atlantic sturgeon have swimming capabilities at least equal to shortnose sturgeon, both species should be able to avoid becoming impinged on the trash bars and intake screens. This is a reasonable assumption given that the Atlantic sturgeon that would be present in the action area are at least of a similar size to the shortnose sturgeon tested by Kynard and because these species have similar body forms, we expect swimming ability to be comparable between individuals of similar sizes. As a condition of their existing license, NextEra must report to NRC any observations of listed species. No Atlantic or shortnose sturgeon have been documented as impinged at Seabrook.

No whales or sea turtles have been observed impinged at the Seabrook intakes (NRC 2010). We have considered whether there is the potential for future impingement at Seabrook. All whales and sea turtles that may be present in the action area are too large to pass through the trash bars (i.e., they have body widths much larger than 5-inches). Whales in the action area are expected to be at least 13 feet long (the minimum size of newborn calves, which is the smallest size of these whale species anywhere; NMFS OPR 2012), with body widths of several feet. Whales are too large to pass through the trash racks and become impinged on the traveling screens. Whales are capable of swimming speeds of several miles per hour; the low intake velocity at the trash rack (1.0-foot per second; NRC 2007) makes it extremely unlikely that any whales would be impinged at the intakes. We are not aware of any incidences of whales becoming impinged on cooling water intakes anywhere in the U.S.

The impingement of sea turtles has been documented at some (e.g., Oyster Creek, NJ; St. Lucie, FL), but not all, nuclear power plants on the U.S. East Coast. As noted above, no sea turtles have been recorded at the Seabrook intakes. No sea turtle impingements have been recorded at any other power plant with a cooling water intake in New England, including the Pilgrim (MA) and Millstone (CT) nuclear power plants. Factors related to the potential for impingement likely include intake velocity (animals may have more difficulty escaping areas with higher intake velocity), plant location, and the physical features of the intake structure (for example, sea turtle impingement at the Salem, NJ nuclear facility was nearly eliminated after ice barriers were seasonally removed from the intakes (NRC 2010)). Sea turtles are strong swimmers and are likely to be able to avoid impingement at the Seabrook intakes; the lack of any impingement in the past is consistent with this conclusion.

Based on this analysis, the impingement or entrainment of any whales, sea turtles, shortnose or Atlantic sturgeon is extremely unlikely to occur during the extended operating period. This conclusion is supported by past monitoring data as reported in the BA and DEIS; no shortnose or Atlantic sturgeon, whales or sea turtles have been observed as impinged or entrained at the intakes.

Impingement and Entrainment - Effects on Prey

As described in Section 2.2.6 of the DSEIS, NextEra has conducted monitoring studies for plankton, fish, invertebrates, and macroalgae since the 1970s. NextEra used a BACI design to test for potential impacts from operation of Seabrook. According to NRC, this monitoring design can be used to test the statistical significance of differences in community structure and abundance between the preoperation and operational period at nearfield and farfield sites. If a significant difference occurs in the geographical distribution of a population, it could be due to entrainment, impingement, heat shock, or a combination of the cumulative effects from Seabrook operations.

Below, we consider the effects of the loss of potential prey species due to impingement or entrainment at Seabrook. Despite the fact that whales and sea turtles are unlikely to occur in the action area, there is the potential for these species to be affected by the loss of prey at Seabrook.

Right Whales

Right whales feed almost exclusively on copepods, a type of zooplankton. Of the different kinds of copepods, North Atlantic right whales feed especially on late stage *Calanus finmarchicus*, a large calanoid copepod (Baumgartner *et al.*. 2007), as well as Pseudocalanus spp. and Centropages spp. (Pace and Merrick 2008). Because a right whale's mass is ten or eleven orders of magnitude larger than that of its prey (late stage *C. finmarchicus* is approximately the size of a small grain of rice), right whales are very specialized and restricted in their habitat requirements – they must locate and exploit feeding areas where copepods are concentrated into high-density patches (Pace and Merrick 2008). As noted above, the action area is outside the "foraging region" for right whales and is not known to support the high densities of copepods necessary for right whales to feed in the area (Pace and Merrick 2008).

As described fully in the DSEIS, NRC has concluded that the operation of Seabrook has not noticeably altered zooplankton abundance (including copepods) near Seabrook. This determination was based on comparisons of zooplankton composition and density at a nearfield and farfield site over time.

Entrainment studies at Seabrook have focused on fish eggs and larvae and bivalve larvae (see Section 4.5.2 of the DSEIS) No estimates of the number of copepods entrained are available. NRC indicates that the issue of zooplankton entrainment has been considered generically. As stated in the GEIS (see section 4.2.2.1.1 in NRC 1996), because of large numbers and short regeneration times of phytoplankton and zooplankton (most copepods live from one week to several months), impacts of entrainment on these organisms have rarely been documented outside the immediate vicinity of any plant and are considered to be of little consequence (referencing Schubel and Marcy 1978; Hesse *et al.*. 1982; Kennish *et al.*. 1984; MDNR 1988; MRC 1989; EPRI EA-1038). NRC states that the effects of entrainment at nuclear plants are not expected to cause or contribute to cumulative impacts to populations of zooplankton or phytoplankton. NRC also states that the effects of phytoplankton and zooplankton entrainment are localized (i.e., the affected areas are smaller than the distances between power plants) and are not expected to contribute to cumulative impacts because generation times of plankton are rapid. NRC further states that review of the literature and operational monitoring reports did not reveal evidence of cumulative impacts from entrainment of phytoplankton and zooplankton. Based on this analysis, NRC has concluded that any effects to zooplankton, including copepods, would be small and localized. "Small" effects are defined by NRC as, "environmental effects [that are] not detectable or are so minor that they will neither destabilize or noticeably alter any important attribute of the resource" (see NRC 2007 at p. iii).

We expect that if the continued operation of Seabrook was having an effect on the zooplankton and copepod community in the Gulf of Maine, that there would be a negative trend in zooplankton and copepod abundance in the area since Seabrook became operational. As noted above, extensive pre- and post-operation monitoring has been carried out at Seabrook. As reported in the DEIS NextEra compared the density of holoplankton, meroplankton, and hyperbenthos taxa prior to and during operation at nearfield and farfield sites (3-8 miles away from the intakes and discharge and considered to be outside the influence of the facility). No significant difference in the density of holoplankton (copepods are considered holoplankton) or meroplankton taxa prior to and during operations or between the nearfield and farfield sampling sites were reported. These results suggest that Seabrook operations have not noticeably altered holoplankton or meroplankton density near Seabrook in the more than 20 years that Seabrook has been operating.

We expect that during the extended operating period, copepods will continue to be entrained and that some of the those copepods may be of the three types that are preferred by right whales. However, studies conducted at Seabrook, and at other nuclear power plants, indicate that any losses of copepods are not detectable outside of natural variability. If Seabrook was having more than an insignificant effect on copepod populations within the Gulf of Maine, we expect that the monitoring studies conducted by NextEra would have detected a negative trend over time.

Right whales are not known to occur in the action area and it is outside the area where dense concentrations of copepods form. While some copepods are likely lost to entrainment at Seabrook each year and these losses, if they were the right species would reduce the amount of prey available to right whales, these reductions will be insignificant and undetectable from natural variability. As such, we expect any effects to foraging right whales to be insignificant.

Humpback and fin whales
Humpback and fin whales feed on krill and small schooling fish, primarily Atlantic herring[3], mackerel and sand lance. Other species that humpbacks are reported to forage on while in the North Atlantic include capelin, pollock, and haddock. Other species that humpbacks are reported to forage on while in the North Atlantic include capelin, pollock, and haddock. Capelin (*Mallotus villosus*) are not recorded as being impinged or entrained at Seabrook (NRC 2011 and NextEra 2010).

Atlantic mackerel (*Scomber scombrus*) have been occasionally impinged at Seabrook, while eggs and larvae are regularly entrained. As described in the 2010 Environmental Report (NextEra 2010), the mean annual loss of Atlantic mackerel "equivalent adults" attributable to entrainment is 469 individuals and the number of adult equivalents attributable to impingement is two. While the annual loss of Atlantic mackerel at Seabrook over the 20-year operating period will result in fewer fish that are available for large whales to eat, this loss represents an extremely small percentage of the Atlantic herring available to these species. Because of this, any effects to foraging whales will be insignificant.

Atlantic herring (*Clupea harengus*) have been impinged and entrained at Seabrook. The mean number of Atlantic herring impinged at Seabrook is 287 individuals per year with mean entrainment of 9.6 million larvae/year. NextEra reports a mean of 484 adult equivalent herring impinged or entrained at Seabrook each year. Atlantic herring are a prolific, widely distributed species; the most recent stock assessment report (TRAC 2009) indicates that this species has fully recovered from past overfishing. At the beginning of 2008, the biomass was approximately

[3] It is important to distinguish between Atlantic herring and the species commonly referred to as "river herring" because there are often references made to "herring" without further specificity about which species is being referred to. Atlantic herring are a marine species that occurs exclusively in saline waters; these small schooling fish are preyed upon by large whales. The term river herring refers to alewife and blueback herring which are small anadromous fish that spawn in rivers and then make oceanic migrations.

652,000 metric tons; the 2005 year class was approximately 3.3 billion individuals. While the loss of Atlantic herring at Seabrook results in fewer fish that are available for large whales to eat, this loss represents an extremely small percentage of the Atlantic herring available to these species. Because of this, any effects to foraging whales will be insignificant.

Sand lance are a common, widely distributed species. American sand lance (*Ammodytes americanus*) are impinged at Seabrook (NRC 2011), with an annual mean impingement of 476 individuals. Collette and Klein-MacPhee (2002) report that the abundance of sand lance in the western North Atlantic in 1987 was approximately 500,000 metric tons. Studies conducted for NextEra indicate that the density of sand lance at the nearfield sampling sites is lower now than it was prior to operations; at the farfield sites, the density of sand lance has increased. However, neither NextEra nor NRC have made any conclusions as to whether this decrease in nearfield density is attributable to Seabrook. However, because large whales are unlikely to be foraging in the action area, and are more likely to be foraging near the farfield stations, where abundance has increased, any reductions in sand lance that may be attributable to Seabrook operations are likely to have insignificant effects to foraging whales.

Humpback whales may feed occasionally on pollock and haddock. NextEra reports that the impingement and entrainment of haddock is rare (NRC 2011). The annual entrainment estimate for cod and hake (inclusive of haddock) is 670 adult equivalents annually. The annual impingement estimate for these species is 61 adult equivalents annually. Considering that an average female haddock lays 850,000 eggs (Brodziak and Traver 2006), and the Georges Bank stock of haddock has a spawning stock biomass of 120,000 metric tons (NMFS 2003), the loss of haddock at Seabrook represents an extremely small percentage of the haddock available to whales.

The annual entrainment estimate for pollock is 21 adult equivalents annually. The annual impingement estimate for pollock is 121 adult equivalents annually. Estimates of pollock abundance were 196,000 metric tons in 2009. The loss of pollock at Seabrook represents an extremely small percentage of the pollock available to foraging whales. Because of this, any effects to foraging whales will be insignificant.

Other small schooling fish that are impinged or entrained at Seabrook include alewives and river herring. Fin and humpback whales are not known to prey on either of these species (see NMFS 1991 and NMFS 2010 for descriptions of the diet of humpback and fin whales).

Loggerhead sea turtle

Loggerhead turtles feed on benthic invertebrates such as gastropods, mollusks and crustaceans. As reported in the DSEIS, NextEra compared the abundance of rock crab (*Cancer irroratus*) and Jonah crab (*Cancer borealis*) larvae, juveniles, and adults prior to and during operation at nearfield and farfield sites. There were no observations of significant differences in the abundance of crab larvae or juvenile and adult crabs prior to and during operations or between sampling sites. While the loss of benthic invertebrates, including crabs, at Seabrook results in fewer individuals that are available for sea turtles to eat, this loss is expected to be an extremely small percentage of the forage available to these species. Because of this, any effects to foraging sea turtles will be insignificant.

Leatherback sea turtle
Leatherback sea turtles feed exclusively on jellyfish. The DEIS does not provide an estimate of the number of jellyfish likely to be killed and no studies on jellyfish density were completed. We requested information from NRC on the impingement of jellyfish at Seabrook. NRC states that there is no indication that Seabrook is impinging jellyfish. Long term monitoring of meroplankton, which includes the larval stage of jellyfish indicates relatively stable abundances and community structure for meroplankton over time (NRC 2011). Based on this information, any loss of jellyfish at Seabrook is likely limited to entrainment of larvae; however, because there has been no detected change in abundance over time it is likely that the effect of this loss is not detectable. Because of this, any effects to foraging leatherbacks will be insignificant.

Sturgeon
Atlantic sturgeon feed on benthic invertebrates and occasionally on sand lance. Shortnose sturgeon feed exclusively on benthic invertebrates. As benthic invertebrates are immobile and do not occur in the upper water column where they could be vulnerable to impingement or entrainment, the only life stages of Atlantic sturgeon prey that are vulnerable to impingement or entrainment are sand lance eggs and larvae. The DSEIS reports that there was some change in benthic community structure during the operation period; however, because changes were observed at the nearfield and farfield sites, these changes are unlikely to be related to operations of Seabrook. Based on the information provided in the DSEIS, any loss of benthic invertebrates and fish eggs and larvae at Seabrook is likely to be small and effects to shortnose or Atlantic sturgeon would be insignificant and discountable.

Discharge of heated effluent
Heated effluent is discharged from the Seabrook outfalls. The thermal effluent from Seabrook is discharged through 11 riser shafts, spaced approximately 100 ft (30.5 m) apart for a total diffuser length of 1,000 ft (305 m) (NAI, 2001). Each riser shaft terminates in a pair of nozzles that are pointed up at an angle of about 22.5 degrees (NAI, 2001). The nozzles are located about 6.5–10 ft (2–3 m) above the seafloor in depths of approximately 49–59 ft (15–18 m) of water (NAI, 2001). The NPDES permit allows discharge of 720 mgd (2.7 million m3/day) on both an average monthly and maximum daily basis. The permit also limits the rise in monthly mean temperature to 5 degrees Fahrenheit (approximately 3°C) in the "near field jet mixing region" which is defined as the area within 300 feet of the submerged diffusers. Given the length of the thermal diffusers (1,000 feet), the NPDES permit allows an increase of 5°F in an area 1,000 feet long by 300 feet wide (approximately 7 acres). NextEra completed a 100 watt electrical uprate in November 2006 which resulted in an increase in heated discharge (NextEra 2010). However, surface and bottom water sampling conducted from 2006-2010 confirms that discharges still meet the terms of the 2002 NPDES permit (NextEra 2010).

As reported in the DSEIS, Padmanabhan and Hecker (1991) conducted a thermal plume modeling and field verification study. This study estimated a temperature rise of approximately 36 to 39 degrees Fahrenheit (20 to 22 degrees Celsius) at the diffusers (Padmanabhan and Hecker, 1991). Field and modeling data indicated that the water rose relatively straight to the surface and spread out within 10–16 ft (3–5 m) of the ocean surface. At the surface, Padmanabhan and Hecker (1991) observed a temperature rise of 3 degrees Fahrenheit (1.7 degrees Celsius) or more within 32 acres (ac) (12.9 hectares (ha)) of the discharge.

Padmanabhan and Hecker (1991) did not observe significant increases in surface temperature 1,640 ft (500 m) to the northwest of the discharge structure.

NRC also reports in the DSEIS that NextEra has conducted monitoring of water temperature at bottom and surface waters near the discharge structure during operations (NAI, 2001; NAI, 2010). NextEra monitored bottom water temperature at a site 656 ft (200 m) from the discharge and at a site 3–4 nautical mi (5–8 km) from the discharge from 1989–1999 (NAI, 2001). NextEra observed a significant difference in the monthly mean bottom water temperature between the two sites. The mean difference was less than 0.9 degrees Fahrenheit (0.5 degrees Celsius) (NAI, 2001). NextEra conducts continuous surface water monitoring. The mean difference in temperature between a sampling station within 328 ft (100 m) of the discharge and a sampling station 1.5 mi (2.5 km) to the north has not exceeded 5 degrees Fahrenheit (2.8 degrees Celsius). For the majority of months between August 1990 and December 2009, the monthly mean increase in surface water temperature was less than 3.6 degrees Fahrenheit (2.0 degrees Celsius).

<u>*Effects of the Thermal Plume*</u>

Whales

As evidenced by the lack of any sightings of right, fin or humpback whales in the action area, these species are unlikely to occur in the area where water temperatures are elevated above ambient. Right whales have been recorded at sea surface temperatures (SST) of 0.0-21.8°C (Kenney in Kraus and Rolland 2007); humpback whales at SST up to 32°C (NMFS 1991) and fin whales at SST up to 28°C (NMFS 2010). These species show tolerance for changing temperatures as reflected by movements through varied water temperatures over periods of minutes to weeks (Kenney in Kraus and Rolland 2007).

Sea surface temperatures in the action area range from 3.1-17.5°C. Assuming that right whales may be negatively affected at water temperatures of 21.8°C (the maximum temperature where they have been recorded) and humpback and fin whales at temperatures of 28 and 32°C respectively above, to consider direct effects to whales from the thermal plume (i.e., stress that may cause injury or mortality or avoidance behavior), we would consider the area where water could be heated to above these temperatures. The highest ambient water temperature in the action area is 17.5°C, so water would need to be heated more than 4°C to reach a level that may be stressful for right whales and more than 10°C to reach a level that may be stressful for humpback and fin whales. The area with temperatures greater than 21.8°C would be limited to less than 7 acres as this is the size of the area where temperatures may be higher than 3°C above ambient (expected maximum of 20.5°C outside of this area). Because of the directional nature of the diffusers which directs warm waters towards the surface and the thermal characteristics of water generally (warm water is less dense than cold water and generally remains at the surface), the benthic area affected by the discharge is even smaller. We expect that any whales that are in the action area would avoid waters that have stressful temperatures by swimming under or around them. Because the area of the plume that would be avoided is extremely small any avoidance will not result in any disruption or delay in any essential behaviors that these species may be carrying out in the action area, including foraging, migrating or resting. Additionally, there is not expected to be any increase in energy expenditure that has any detectable effect on the physiology of any individuals or any future effect on growth, reproduction, or general health.

Sea turtles

Excessive heat exposure (hyperthermia) is a stress to sea turtles but is a rare phenomenon when sea turtles are in the ocean (Milton and Lutz 2003). As such, limited information is available on the impacts of hyperthermia on sea turtles. Based on the lack of sightings, it is unlikely that any sea turtles will occur in the action area. However, because it is possible, we have considered the potential effects of exposure to the thermal plume. All sea turtle species are known to regularly occur in waters of at least 28°C; Caribbean waters can be even warmer in the low to mid 30s. Environmental temperatures above 40°C can result in stress for green sea turtles (Spotila *et al.*. 1997). Even assuming that a water temperature greater than 28°C could be stressful for sea turtles, as explained above, even when ambient temperatures are the warmest (17.5°C), the surface area heated to 20.5°C or higher is approximately 7 acres with the area experiencing temperatures of 28°C or higher even smaller. Sea turtles could avoid the heated area of the bottom by swimming around it and could avoid the surface area by swimming underneath it. Given the small size of this area, any avoidance will not result in any disruption or delay in any essential behaviors that these species may be carrying out in the action area, including foraging, migrating or resting. Additionally, there is not expected to be any increase in energy expenditure that has any detectable effect on the physiology of any individuals or any future effect on growth, reproduction, or general health.

We have considered whether the thermal effluent discharged from the plant may represent an attraction for turtles. If turtles are attracted by this thermal plume, they could remain there late enough in the fall to become cold-stunned. Cold stunning occurs when water temperatures drop quickly and turtles become incapacitated. The turtles lose their ability to swim and dive, lose control of buoyancy, and float to the surface (Spotila *et al.*. 1997). If sea turtles are attracted to the heated discharge or remain in surrounding waters heated by the discharge and move outside of this plume into cooler waters (approximately less than 8-10°C), they could become cold stunned. While no one has studied the distribution of sea turtles in the Gulf of Maine to determine whether the thermal effluent associated with Seabrook affects sea turtle distribution; existing data from other nuclear power plants in the NMFS Northeast Region do not support the concern that warm water discharge may keep sea turtles in the area until surrounding waters are too cold for their safe departure. For example, extensive data is available on sea turtles at the Oyster Creek facility in New Jersey (OCNGS; NMFS NERO 2011). We expect cold-stunning to occur around mid-November in New Jersey waters. No incidental captures of sea turtles have been reported at the OCNGS later than October 30, with the minimum recorded temperature at time of capture of 11.7°C (this turtle was alive and healthy, not cold stunned), suggesting that the thermal effluent is not increasing the risk of cold stunning.

There are several factors that may make it unlikely that the thermal effluent from Seabrook increases the risk of cold-stunning of sea turtles. During the winter, when water temperatures are low enough for cold stunning to occur, the area where the water temperatures would be suitable for sea turtles is transient, small and localized. In order to stay in the action area once ambient waters cool in the Fall, sea turtles would need to find areas where temperatures higher than at least 11°C would consistently be found. While there is warm water discharged from Seabrook year round and there are nearly always areas where water is heated to above 11°C, the amount of water that is at this temperature is highly variable and because the plume is primarily at the surface, there would be very little time, if any, when warm enough water would be present throughout the water column. Because sea turtles are benthic feeders and must dive down away from the surface to eat, being restricted to surface waters would preclude long term use of this area. Given the transient nature of the thermal plume, its presence at the surface, and the small size of the area that would have temperatures that would support sea turtles, it is extremely unlikely that sea turtles would seek out and use the thermal plume for refuge from falling temperatures in the Gulf of Maine. Because of this, it is extremely unlikely that sea turtles would remain unseasonably long in the action area because of the presence of heated water from Seabrook. Based on the best available information, it is extremely unlikely that the discharge of heated effluent increases the vulnerability of sea turtles in the action area to cold stunning.

Atlantic and shortnose sturgeon
Limited information on the thermal tolerances of Atlantic sturgeon is available. Atlantic sturgeon have been observed in water temperatures above 30°C in the south (see Damon-Randall *et al.* 2010). In the laboratory, juvenile Atlantic sturgeon showed negative behavioral and bioenergetics responses (related to food consumption and metabolism) after prolonged exposure to temperatures greater than 28°C (82.4°F) (Niklitschek 2001). Tolerance to temperatures is thought to increase with age and body size (Ziegweid *et al.*. 2008 and Jenkins *et al.*. 1993), however, no information on the lethal thermal maximum or stressful temperatures for subadult or adult Atlantic sturgeon is available. Shortnose sturgeon, which are likely to be a reasonable surrogate for Atlantic sturgeon given similar geographic distribution and known biological similarities, have been documented in the lab to experience mortality at temperatures of 33.7°C (92.66°F) or greater.

We first consider the potential for Atlantic and shortnose sturgeon to be exposed to temperatures which are expected to result in behavioral avoidance (28°C). The maximum ambient temperature is expected to be 17.5°C. As explained above, even when ambient temperatures are there warmest, the surface area that Atlantic or shortnose sturgeon are likely to avoid (28°C) is less than 7 acres. The benthic area is even smaller. Atlantic and shortnose sturgeon exposure to the surface area where water temperature may be elevated above 28°C is limited by their normal behavior as benthic-oriented fish, which results in limited occurrence near the water surface. Any surfacing sturgeon are likely to avoid near surface waters with temperatures greater than 28°C. Reactions to this elevated temperature are expected to consist of swimming away from the plume by traveling deeper in the water column or swimming around the plume. As the area that would be avoided is at or near the surface, away from bottom waters where sturgeon spend the majority of time and complete all essential life functions that are carried out in the action area (foraging, migrating, resting), and given the small area that may have temperatures elevated above 28°C it is extremely unlikely that these minor changes in behavior will preclude any shortnose or Atlantic sturgeon from completing any essential behaviors such as resting, foraging or migrating or that the fitness of any individuals will be affected. Additionally, there is not expected to be any increase in energy expenditure that has any detectable effect on the physiology of any individuals or any future effect on growth, reproduction, or general health.

We have considered the potential for Atlantic or shortnose sturgeon to be exposed to temperatures that could result in mortality (33.7°C or greater). Because we expect Atlantic sturgeon to avoid waters with temperatures greater than 28°C, it is extremely unlikely that they would swim through those waters to reach areas where the water is warm enough to result in mortality. Given that fish are known to avoid areas with unsuitable conditions and that Atlantic and shortnose sturgeon are likely to actively avoid heated areas, as evidenced by Atlantic sturgeon moving to deep cool water areas during the summer months (see ASSRT 2007 and Damon-Randall *et al.* 2010), it is likely that any sturgeon in the action area will avoid the area where temperatures are greater than tolerable. As such, it is extremely unlikely that any Atlantic or shortnose sturgeon would remain within the area where surface temperatures are elevated to 33.7°C (92.7°F) and be exposed to potentially lethal temperatures. This risk is further reduced by the limited amount of time sturgeon spend near the surface, the small area where such high temperatures will be experienced and the gradient of warm temperatures extending from the outfall; if any sturgeon are present, they are likely to begin avoiding areas with temperatures greater than 28°C (82.4°F) and are unlikely to remain within the heated surface waters or swim towards the outfall and be exposed to temperatures which could result in mortality.

We have considered whether the avoidance behavior expected for whales, sea turtles, Atlantic and shortnose sturgeon discussed above, constitutes "take" as defined by the ESA. NMFS has not defined "harassment," a type of take under the ESA. The term "harass" has not been defined by NMFS; however, it is commonly understood to mean to annoy or bother. In addition, legislative history helps elucidate Congress' intent: "[take] includes harassment, whether intentional or not. This would allow, for example, the Secretary to regulate or prohibit the activities of birdwatchers where the effect of those activities might disturb the birds and make it difficult for them to hatch or raise their young" (HR Rep. 93-412, 1973). The U.S. Fish and Wildlife Service has defined harassment to mean, "an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly impair normal behavioral patterns including breeding, feeding or sheltering" (50 CFR 17.3). For purposes of this consultation, we interpret harassment to be a significant disruption or delay in carrying out essential behaviors that is likely to cause injury. As explained above, we do not anticipate any significant impairment of any normal behaviors that is likely to cause injury as a result of avoidance of heated waters. Therefore, we do not anticipate any avoidance-related effects to listed species from the thermal plume to rise to the level of take.

Effects to Prey

We have considered the potential for heated effluent to affect the abundance or distribution of prey in the action area.

Loggerhead sea turtles, as well as Atlantic and shortnose sturgeon, feed on benthic invertebrates. Mobile invertebrates are likely to avoid the area where temperatures are above their thermal tolerance. Considering that the maximum benthic area where water temperatures would be 3°C above ambient is limited to an area within 300 feet of the diffuser array, all effects to the benthic community due to the thermal plume are expected to be limited to this area. Given the small area that these benthic prey species would be displaced and the likelihood that these species would avoid intolerant temperatures and not be injured or killed due to exposure to intolerable temperatures, any effects to foraging loggerhead sea turtles, Atlantic sturgeon and shortnose sturgeon will be insignificant and limited only to the distribution of their prey away from the thermal plume.

Leatherbacks foraging off Massachusetts primarily consume the scyphozoan jellyfishes, *Cyanea capillata* and *Chrysaora quinquecirrha* (Dodge *et al.* 2011). There are no studies documenting the diet of leatherbacks off the coast of New Hampshire; however, given the geographic nearness of these areas we assume that any leatherbacks in the action area would also be foraging on these species The thermal tolerance of *Chrysaora quinquecirrha* is approximately 30°C (Gatz *et al.*. 1973); *Cyanea capillata* experience mortality at temperatures of 34-36°C (Cargo and Schultz 1967). The area where these temperatures could be experienced is small and limited at the bottom and surface to an area no larger than 7 acres (see above). Given the small area that these prey species would be displaced and the likelihood that these species would avoid intolerant temperatures and not be injured or killed due to exposure to intolerable temperatures, any effects to foraging leatherback sea turtles will be insignificant and limited only to the distribution of their prey away from the thermal plume.

The distribution of fish species that humpback and fin whales prey upon could be affected by the thermal plume. Field studies on the distribution of Atlantic herring indicate that this species prefers temperatures below 16°C (Collette and Klein-MacPhee 2002); thus, this species is unlikely to be in the action area when ambient temperatures are above 16°C. When ambient temperatures are below 16°C, the surface area above their preferred temperature would be less than 7 acres. Sand lance tolerate temperatures up to 11°C, but are most common at temperatures up to 6°C. This species is benthic and not present at the surface. The area of the bottom that could be warm enough to affect this species is less than 7 acres. Pollock can tolerate temperatures up to 14°C, but adults do not occur at the surface when temperatures are greater than 11.1°C (Collette and Klein-MacPhee 2002); similar to Atlantic herring, the area that would be avoided by this species is limited to less than 7 acres at the surface and at the bottom. Mackerel tolerate temperatures up to about 20°C. The area that would be avoided by this species is also limited to less than 7 acres at the surface and at the bottom. Given the small area that prey species for humpback and fin whales would be displaced and the likelihood that these species would avoid intolerant temperatures and not be injured or killed due to exposure to intolerable temperatures, any effects to foraging humpback and right whales will be insignificant and limited only to the distribution of their prey away from the thermal plume.

As discussed above, right whales feed on copepods, primarily on C. finmarchicus, but also Pseudocalanus spp. and Centropages spp. Different populations of *C. finmarchicus* are thought to have variable thermal tolerances; this species has been documented in the wild where temperature measurements or estimates ranged from 3.1 to 28.1°C; this species was most abundance where water temperatures ranged from 7 – 13°C and very scare where it was above 21°C (Kane 2005). Halcrow (1963) reported this species being found in waters of -2 to 22°C. A lab study indicated *C. finmarchicus* sampled from the Gulf of Maine, did not experience mortality upon exposure of temperatures of 18°C for 24 hours, but did have mortality when exposed to this temperature for up to 48 hours (Voznesensky *et al.* 2004). A lab study indicated survival of *C. finmarchicus* was unaffected by temperatures up to 13.5°C (Willis 2007). Centropages spp. are found at temperatures from 1-24°C (Bonnet *et al.* 2007); Pseudocalanus spp. are found at temperatures up to at least 20°C (Ji *et al.* 2009). Copepods are mobile and can move through the water column. Copepod distribution is not likely to be affected at temperatures below 21°C (see citations referenced above). The area warmed to above this temperature is less than 7 acres. Given the small size of the area where the distribution of copepods would be affected and that copepods are likely to avoid the area rather than be injured or killed, any effect to foraging right whales is extremely unlikely.

Other Pollutants Discharged from the Facility

Pollutants discharged from Seabrook are regulated under the facility's NPDES permit (EPA 2002). Limits on the concentration of pollutants in effluent are included when required for a specific type of facility or when a reasonable potential analysis indicates that there is a reasonable potential for an excursion from a water quality standard (then, a water quality based limit is required). The NPDES permit also regulates thermal discharges (see above), total residual oxidants (chlorine is used to control biofouling), pH, Oil and Grease, Total Suspended Solids (TSS), Copper, and Iron. The permit also requires WET testing. All pollutant limits authorized by the NPDES permit to be discharged by Seabrook are at levels at or below EPA's aquatic life criteria.

Water quality criteria are developed by EPA for protection of aquatic life (see http://water.epa.gov/scitech/swguidance/standards/current/index.cfm for current criteria table; last accessed May 1, 2012). Both acute (short term exposure) and chronic (long term exposure) water quality criteria are developed by EPA based on toxicity data for plants and animals. Often, both saltwater and freshwater criteria are developed, based on the suite of species likely to occur in the freshwater or saltwater environment. For aquatic life, the national recommended toxics criteria are derived using a methodology published in *Guidelines for Deriving Numeric National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses* (EPA 1985). Under these guidelines, criteria are developed from data quantifying the sensitivity of species to toxic compounds in controlled chronic and acute toxicity studies. The final recommended criteria are based on multiple species and toxicity tests. The groups of organisms are selected so that the diversity and sensitivities of a broad range of aquatic life are represented in the criteria values. To develop a valid criterion, toxicity data must be available for at least one species in each of eight families of aquatic organisms. The eight taxa required are as follows: (1) salmonid (e.g., trout, salmon); (2) a fish other than a salmonid (e.g., bass, fathead minnow); (3) chordata (e.g., salamander, frog); (4) planktonic crustacean (e.g., daphnia); (5) benthic crustacean (e.g., crayfish); (6) insect (e.g., stonefly, mayfly); (7) rotifer, annelid (worm), or mollusk (e.g., mussel, snail); and, (8) a second insect or mollusk not already represented. Where toxicity data are available for multiple life stages of the same species (e.g., eggs, juveniles, and adults), the procedure requires that the data from the most sensitive life stage be used for that species.

The result is the calculation of acute (criteria maximum concentration (CMC)) and chronic (criterion continuous concentration (CCC)) criteria. CMC is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed briefly (i.e., for no more than one hour) without resulting in an unacceptable effect. The CCC is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed indefinitely without resulting in an unacceptable effect. EPA defines "unacceptable acute effects" as effects that are lethal or immobilize an organism during short term exposure to a pollutant and defines "unacceptable chronic effects" as effects that will impair growth, survival, and reproduction of an organism following long term exposure to a pollutant. The CCC and CMC levels are designed to ensure that aquatic species exposed to pollutants in compliance with these levels will not experience any impairment of growth, survival or reproduction.

Data on toxicity as it relates to whales, sea turtles, and Atlantic sturgeon is extremely limited. In the absence of species specific chronic and acute toxicity data, the EPA aquatic life criteria represent the best available scientific information. Absent species specific data, NMFS believes it is reasonable to consider that the CMC and CCC criteria are applicable to NMFS listed species as these criteria are derived from data using the most sensitive species and life stages for which information is available. As explained above, a suite of species is utilized to develop criteria and these species are intended to be representative of the entire ecosystem, including marine mammals and sea turtles and their prey. These criteria are designed to not only prevent mortality but to prevent all "unacceptable effects," which, as noted above, is defined by EPA to include not only lethal effects but also effects that impair growth, survival and reproduction.

For the Seabrook facility, the relevant water quality criteria are the New Hampshire water quality criteria, which must be certified by EPA every three years. This certification process is designed to ensure that the New Hampshire water quality standards are consistent with, or more protective than, the EPA national recommended aquatic life criteria. Based on this reasoning outlined above, for the purposes of this consultation, NMFS considers that pollutants that are discharged with no reasonable potential to cause excursions in water quality standards, will not cause effects that impair growth, survival and reproduction of listed species. Therefore, the effect of the discharge of these pollutants at levels that are less than the relevant water quality standards, which by design are consistent with, or more stringent than, EPA's aquatic life criteria, will be insignificant on NMFS listed species.

Radiological Impacts

We have reviewed the information presented in the FEIS and the most recent reports of the Radiological Evaluation Monitoring Report ((REMP) NextEra 2009, 2010 and 2011) as well as the Radiological Effluent Release Reports for those same years to assess any radiological impacts to listed species or their prey.

The quarterly composites and samples of surface water showed no indication of tritium. Tritium results for all surface water samples were so low as to be below the detection capability of the analysis method (i.e., less than the lower limit of detection (LLD) of 3,000 pCi/kg for seawater). NRC reports that these results are consistent with preoperational tritium data (NRC 2011). The analysis for gamma radiation emitting material in all surface water samples showed no indication of any gamma-emitting radionuclides related to Seabrook plant operation. The only radionuclide detected in 2009 was naturally-occurring Potassium-40 (40 K). No plant-related nuclides were detected. The present data for gamma emitters in seawater do not indicate any measurable impact from Seabrook plant operation.

Analysis of sediment samples for gamma-emitting radionuclides showed the presence of naturally-occurring radionuclides K and Thorium-232 (232 Th). No plant-related radionuclides were detected. The sediment sample results do not indicate any measurable impact from Seabrook plant operation.

Bottom dwelling fish species (winter and yellow tail flounder) and fish species that reside in the upper water column (cunner fish) were collected for analysis. Analysis of fish samples collected at both the indicator location and the control location identified the presence of only naturally-occurring radionuclides (40 K). The fish sample results do not indicate any measurable impact from Seabrook plant operation.

Analysis of mussel samples collected at both the indicator station near the discharge outfall and the control station in Ipswich Bay identified only naturally-occurring radionuclides (40 K). The mussel shells were tested for Strontium-90 (90 Sr) but no indication of any 90 Sr incorporation into the shell was found. The shellfish sample results do not indicate any measurable impact from Seabrook plant operation.

Analysis of Irish moss (algae) samples, collected at both the indicator station near the plant discharge and a control location in Ipswich Bay, identified only naturally-occurring radionuclides 40 K and Beryllium-7 (7 Be). According to NRC, one sample taken from the control location detected 131 I (31.1 pCi/kg), but a review of effluent discharge records from Seabrook showed no detectable liquid waste release of 131 I. It is unlikely that the 131 I found in the sample could have originated from Seabrook due to the control station's distance of 10.8 mi (17.4 km) from the plant. The medical industry uses for patient treatment, and it is likely that the 131 I detected in the control sample is medically related. The Irish moss sample results do not indicate any measurable impact from Seabrook plant operation.

As reported in the most recent REMPs and in the DSEIS, samples collected as part of the REMP at Seabrook continued to contain detectable amounts of naturally-occurring and man-made radioactive materials. No samples indicated any detectable radioactivity attributable to Seabrook operations. It is important to note that no whales, sea turtles or Atlantic sturgeon have been tested to determine levels of radionuclides; however, because in the most recent years that sampling occurred, no samples of any species have detected radionuclides that would be attributed to Seabrook, it is reasonable to anticipate that similar results would be seen if these listed species were sampled. Based on this information, we do not expect that any whales, sea turtles or Atlantic sturgeon contain any detectable levels of radionuclides attributable to Seabrook. As such, radiological impacts to these species are extremely unlikely. Thus, we consider the effects to listed species and their prey from radionuclides to be insignificant and discountable.

Climate Change

In the future, global climate change is expected to continue and may impact listed species and their habitat in the action area. If the NRC issues an extended operating license, Seabrook could operate until March 15, 2050. We considered climate change impacts in the action area through this date to provide context within which the effects of the action will occur from present to March 2050. Much about the rate of potential climate change and associated changes in weather patterns and ambient water temperatures is unknown; however, as explained below, given the likely rate of change associated with climate impacts in the Gulf of Maine generally and the action area specifically, it is unlikely that climate-related impacts will have a significant effect on the status of listed species over the temporal scale of the proposed action or that in this time period, the abundance, distribution, or behavior of these species in the action area will change as a result of climate change related impacts.

The greatest potential for climate change to impact our assessment would be if (1) ambient water temperatures increased enough such that a larger portion of the thermal plume had temperatures that were stressful for listed species or their prey, or if (2) the status, distribution and abundance of listed species or their prey changed significantly in the action area. Sea surface temperatures have fluctuated around a mean for much of the past century, as measured by continuous 100+ year records at Woods Hole (Mass.), and Boothbay Harbor (Maine) and shorter records from Boston Harbor and other bays. Periods of higher than average temperatures (in the 1950s) and cooler periods (1960s) have been associated with changes in the North Atlantic Oscillation (NAO), which affects current patterns. Over the past 30 years however, records indicate that ocean temperatures in the Northeast have been increasing. For example, Boothbay Harbor's temperature has increased by about 1°C since 1970. The model projections are for an increase of somewhere between 3-4°C by 2100 and a pH drop of 0.3-0.4 units by 2100 (Frumhoff *et al.* 2007). Assuming that there is a linear trend in increasing water temperatures and decreasing pH, one could anticipate a 0.03-.04°C increase each year, with an increase in temperature of 1.14-1.52°C between now and 2050 and a 0.003-0.004 unit drop in pH per year, with a drop of 0.114-0.152 units between now and 2050. Given these predicted changes, it is not likely that over the proposed extended operating period that any water temperature changes would be significant enough to affect the conclusions reached by us in this consultation. If new information on the effects of climate change becomes available then reinitiation of this consultation may be necessary.

Non-routine and Accidental Events

By their nature, non-routine and accidental events that may affect the marine environment are unpredictable and typically unexpected. In the FSEIS, NRC considers design-basis accidents (DBAs) and severe accidents. DBAs are those accidents that both the licensee and the NRC staff evaluate to ensure that the plant can withstand normal and abnormal transients, and a broad spectrum of postulated accidents, without undue hazard to the health and safety of the public. NRC states that the environmental impacts of these DBAs will be "small" (i.e., insignificant), because the plant is designed to withstand these types of accidents including during the extended operating period (NRC 2011).

NRC also states that the risk of severe accidents initiated by internal events, natural disasters or terrorist events is small. As noted by Thompson (2006) in a report regarding the risks of spent-fuel pool storage, the available information does not allow a statistically valid estimate of the probability of an attack-induced spent-fuel-pool fire. However, Thompson states that "prudent judgment" indicates that a probability of at least one per century within the U.S. is a reasonable assumption. There have been very few instances of accidents or natural disasters that have affected nuclear facilities and none at Seabrook that have led to any impacts to the marine environment. While the experience at Fukishima in Japan provides evidence that natural disaster induced problems at nuclear facilities can be severe and may have significant consequences to the environment, the risk of non-routine and accidental events at Seabrook that would affect the marine environment, and subsequently affect listed species is extremely low. Because of this, effects to listed species are discountable. We expect that in the unlikely event of any accident or disaster that affects the marine environment, reinitiation of consultation, or an emergency consultation, would be necessary.

CONCLUSION
As explained above, based on information from NRC, NextEra, and other sources, all effects to listed species will be insignificant or discountable. Therefore, the continued operation of Seabrook under the terms of a renewed operating license is not likely to adversely affect any listed species under our jurisdiction.

Reinitiation of consultation is required and shall be requested by the Federal agency or by us, where discretionary Federal involvement or control over the action has been retained or is authorized by law and: (a) If new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered in the consultation; (b) If the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the consultation; or (c) If a new species is listed or critical habitat designated that may be affected by the identified action. No take is anticipated or exempted; take is defined in the ESA as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct." If there is any incidental take of a listed species, reinitiation would be required. If any whales, sea turtles or Atlantic sturgeon are observed at or near Seabrook, including at the trash racks or on the intake screens, this should be immediately reported to us.

We have identified several areas where additional and/or more recent information would be helpful to better characterize effects of the Seabrook facility. While this information was not necessary to complete this consultation, we request that you consider adding conditions to any new license for Seabrook to require: (1) monitoring and reporting of impingement and entrainment of crabs and jellyfish; (2) monitoring and reporting of zooplankton entrainment, including copepods (particularly, *Calanus finmarchus, Pseudocalanus* spp. and *Centropages* spp); (3) establishing a monitoring program for ambient water temperatures and the thermal effluent to better understand how any changes in ambient water temperatures during the relicensing period, which may partly be related to global and/or regional climatological changes, may change the characteristics and distribution of the thermal plume; and (4) revising the species sampled in the REMP to include species that serve as forage for listed species and species that occupy similar ecological niches as Atlantic and shortnose sturgeon, whales and sea turtles and could be considered surrogate species for radionuclide testing.

Please note that as announced on October 6, 2010 (see 75 FR 61690), we are continuing our ongoing rulemaking process to designate critical habitat for North Atlantic right whales. Should a final rule be promulgated, reinitiation of this consultation may be necessary.

Technical Assistance for Candidate Species
In 2011, we designated blueback herring and alewife as "Candidate Species;" a status review for these species is currently ongoing. NMFS candidate species are those petitioned species that are actively being considered for listing as endangered or threatened under the ESA, as well as those species for which NMFS has initiated an ESA status review that it has announced in the *Federal Register*. For detailed definitions and explanations, please refer to the April 15, 2004 and

October 17, 2006, *Federal Register* notices (69 FR 19975), (71 FR 61022), which revised the Candidate Species definition.

Blueback herring and alewife are impinged annually at Seabrook (NRC 2011). As they are candidate species that could be listed under the ESA in the future, we encourage you to work with Entergy to minimize effects to these species to the maximum extent possible. Monitoring requirements for these species should be incorporated into the new license. We request that any monitoring reports produced that contain information on these species be provided to us. Should either species be listed under the ESA in the future, reinitiation of consultation would be necessary. Questions specific to candidate species and the status review process should be directed to Kimberly Damon-Randall (978) 282-8485.

Coordination with EPA

We are providing EPA with a copy of this letter for their records. If in the future EPA issues a revised NPDES permit for this facility, reinitiation of this consultation, involving both EPA and NRC, is likely to be necessary. Additionally, it is our understanding that revised CWA 316(b) regulations may be issued by EPA in 2012. If there are any modifications to the Seabrook facility resulting from the implementation of these regulations, reinitiation of this consultation is likely to be necessary.

Should you have any questions about this correspondence please contact Kimberly Damon-Randall, Acting Assistant Regional Administrator for Protected Resources at the number provided above.

Sincerely,

John K. Bullard
Regional Administrator

EC: Crocker, F/NER3
Johnson, F/NER4
Logan, Balsam – NRC

File Code: Sec 7 NRC Seabrook Relicensing
PCTS: I/NER/2012/00098

Literature Cited

Atlantic Sturgeon Status Review Team (ASSRT). 2007. Status Review of Atlantic sturgeon (Acipenser oxyrinchus oxyrinchus). Report to National Marine Fisheries Service, Northeast Regional Office. February 23, 2007. 174 pp.

Baumgartner, Mark, Tim V.N. Cole, Robert G. Campbell, Gregory J. Teegarden, and Edward G. Durbin. 2003. Associations between North Atlantic right whales and their prey, Calanus finmarchicus, over diel and tidal time scales. Marine Ecology Progress Series. 264: 155-166

Baumgartner, M. F., Mayo, C. A., and Kenney, R. D. 2007. Enormous carnivores, microscopic food, and a restaurant that's hard to find. In "The Urban Whale: North Atlantic Right Whales at the Crossroads" (S. D. Kraus and R. M. Rolland, eds.), pp. 138 – 171. Harvard University Press, Cambridge, MA.

Bonnet, D. R. Harris, A. Lopz-Urrutia et al. 2007. Comparitive seasonal dynamics of Centropages typicus at seven coastal monitoring stations in the North Sea, English Channel and Bay of Biscay. Progress in Oceanography 72: 233-248.

Bridges, W.L. and R.D. Anderson. 1984. A brief summary of Pilgrim Nuclear Power Plant effect upon the marine aquatic environment. In J.D. Davis and D. Merriman eds. Observations on the ecology and biology of western Cape Cod Bay, Massachusetts. P. 263-271. Lecture Notes on Coastal and Estuarine Studies 11. Springer-Veriag, NY Leigh.

Brodziak, J. and M. Traver. 2006. Status of Fisheries Resources off the Northeastern US – Haddock. NMFS Northeast Fisheries Science Center. Available online at: http://www.nefsc.noaa.gov/sos/spsyn/pg/haddock/archives/02_Haddock_2006.pdf.

Cargo, D.G. and L.P. Schultz. 1967. Further observations on the biology of the sea nettle and jellyfishes in Chesapeake Bay. Chesapeake Science 8:209-220.

CETAP 1982. A characterization of marine mammals and turtles in the mid- and North Atlantic areas of the U.S. outer continental shelf, final report, Cetacean and Turtle Assessment Program, University of Rhode Island. Bureau of Land Management, Washington, DC. #AA551-CT8-48 576. pp.

Colette, B.B. and G. Klein-MacPhee. 2002. Fishes of the Gulf of Maine Third Edition. Smithsonian Institution, Washington DC, 748 pp.

Damon-Randall, K. *et al.* 2010. Atlantic Sturgeon Research Techniques. Woods Hole (MA) NMFS Northeast Fisheries Science Center Technical Memorandum NMFS-NE-215.

Delorenzo Costa, A. E. Durbin, C. Mayo, and E. Lyman. 2006. Environmental factors affecting zooplankton in Cape Cod Bay: implications for right whale dynamics. Marine Ecology Progress Series. 323: 281-298.

Dodge, K.L., Logan, J.M., and M.E. Lutcavage. 2011. Foraging ecology of leatherback sea turtles in the western North Atlantic determined through multi-tissue stable isotope analyses. Marine Biology 158: 2813-2824.

[EG&G] Global Environmental and Ocean Services. 1995. Pilgrim Nuclear Station Cooling Water Discharge Bottom Temperature Study, August 1994. Final Report to Boston Edison Company, Plymouth, Massachusetts. June 1995. 116 p. ADAMS No. ML061450065.

Emberton, KC. 1981. Season-Depth Relations in Subtidal Meiofauna of Cape Cod Bay. *Estuaries* 4(2): 121-126.

ENSR Corporation. 2000. 316 Demonstration Report for Pilgrim Buclear Power Station, Redacted Version. Prepared for Entergy Nuclear Generation Company. March 2000. 357 p. ADAMS No. ML061390357.

Entergy. 2011. Pilgrim Nuclear Power Station Radiological Environmental Operating Report, January 1 through December 31, 2010. Filed with NRC May 2011. 104 pp.

Entergy. 2010. Pilgrim Nuclear Power Station Radiological Environmental Operating Report, January 1 through December 31, 2009. Filed with NRC May 2010. 104 pp.

Entergy. 2009. Pilgrim Nuclear Power Station Radiological Environmental Operating Report, January 1 through December 31, 2008. Filed with NRC May 2009. 104 pp.

Entergy. 2011b. Pilgrim Nuclear Power Station Radioactive Effluent Release Report: January 1 through December 31, 2010. Filed with NRC May 2011. 78 pp.

Entergy. 2010b. Pilgrim Nuclear Power Station Radioactive Effluent Release Report: January 1 through December 31, 2009. Filed with NRC May 2010. 222 pp.

Entergy. 2009b. Pilgrim Nuclear Power Station Radioactive Effluent Release Report: January 1 through December 31, 2008. Filed with NRC May 2009. 73 pp.

Environmental Protection Agency (EPA) Region I. 1994. Modification to Authorization to Discharge Under the National Pollutant Discharge Elimination System MA 0003557. Issued to Entergy Nuclear August 30, 1994.

EPA Region I. 1991. Authorization to Discharge Under the National Pollutant Discharge Elimination System MA 0003557. Issued to Boston Edison Company April 29, 1991.

EPA. 1985. Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses. PB85-227049. 54 pp.

Evans, M., G. Warren and D. Page. 1986. The effects of power plant passage on zooplankton mortalities: eight years of study at the Donald C. Cook nuclear plant. Water Resources 20 (6):

725-734. Huggett, JA and PA Cook. 1991. The effects of entrainment on plankton at Koeberg nuclear power station. South African Journal of Marine Sciences. 11: 211-226.

Frumhoff, P.C., J.J. McCarthy, J.M. Melillo, S.C. Moser, and D.J. Wuebbles. 2007. Confronting Climate Change in the U.S. Northeast: Science, Impacts, and Solutions. Synthesis report of the Northeast Climate Impacts Assessment (NECIA). Cambridge, MA: Union of Concerned Scientists (UCS).

Gangopadhyay, Avijit, Allan R. Robinson, Patrick J. Haley, Wayne G. Leslie, Carlos J. Lozano, James J. Bisagni, and Zhitao Yu. 2003. Feature-oriented regional modeling and simulations in the Gulf of Maine and Georges Bank. Continental Shelf Research.

Gatz, AJ, VS Kennedy, and JA Mihursky. 1973. Effects of Temperature on Activity and Mortality of the Scyphozoan Medusa, Chrysaora quinquecirrha. Coastal and Estuarine Research Federation. 14(3): 171-180.

Greene CH, Pershing AJ, Monger BC, Benfield MC, Durbin EG, Casas MC. 2004. Supply-side ecology and the response of zooplankton to climate-driven changes in North Atlantic Ocean Circulation. Oceanography 17 [3]: 60-71.

Halcrow, K. 1963. Acclimation to Temperature in the Marine Copepod, Calanus Finmarchicus (Gunner.). Limnology and Oceanography. 8(1)1-8.

Hartwell AD, Mogolesko FJ. Three-dimensional field surveys of thermal plumes from backwashing operations at a coastal power plant site in Massachusetts. 10 p. (NRC ADAMS No. ML061420520).

Huggett, JA and PA Cook. 1991. The Effects of Entrainment on Plankton at Koeberg Nuclear Power Station. South African Journal of Marine Science 11: 211-226.

Jenkins, W.E., T.I.J. Smith, L.D. Heyward, and D.M. Knott. 1993. Tolerance of shortnose sturgeon, *Acipenser brevirostrum*, juveniles to different salinity and dissolved oxygen concentrations. Proceedings of the Southeast Association of Fish and Wildlife Agencies, Atlanta, Georgia.

Ji, R. CS Davis, C. Chen, and RC Beardsley. 2009. Life history traits and spatiotemporal distributional patterns of copepod populations in the Gulf of Maine-Georges Bank region. Marine Ecology Progress Series 384: 187-205.

Jiang, S., T. Dickey, D. Steinberg and L. Madin, 2007, Temporal variability of zooplankton biomass from ADCP backscatter time series data at the Bermuda Testbed Mooring Site, Deep Sea Res. I, 54, 608-636.

Kane, J. 2005. The demography of Calanus finmarchicus (Copepoda: Calanoida) in the Middle Atlantic Bight, USA, 1977-2001. Journal of Plankton Research 27(5)401-414.

Kenney, R. 2007. Right Whales and Climate Change: Facing the Prospect of a Greenhouse Future. Pp. 436-459 In: The Urban Whale – North Atlantic Right Whales at the Crossroads. Harvard University Press, Cambridge, MA, 543 pp.

Lenz, P.H., A.E. Hower, and D.K. Hartline. 2005. Temperature Compensation in the Escape Response of a Marine Copepod, Calanus finmarchicus (Crustacea). Biol. Bull. 209: 75-85.

Kynard, B., D. Pugh and T. Parker. 2005. Experimental studies to develop a bypass for shortnose sturgeon at Holyoke Dam. Final report to Holyoke Gas and Electric, Holyoke, MA.

Mayo, Charles. A. and Marilyn K. Marx. 1990. Surface behavior of the North Atlantic right whale, Eubalaena glacialis, and associated zooplankton characteristics. Canadian J. of Zoology. 68(10): 2214-2220.

Milton, S. and P. Lutz. 2003. Physiological and Genetic Responses to Environmental Stress. Pp. 163-197 In: The Biology of Sea Turtles Volume II. Lutz, P., Musick, JA and J. Wuneken, eds. CRC Press, New York. 432 pp.

MIT Department of Civil Engineering 1974. Oceanographic studies at Pilgrim nuclear power station to determine characteristics of condenser water discharge (correlation of field observations with theory). Report No. 183. 156 pp.

Murison, L.D. and D.E. Gaskin. 1989. The distribution of right whales and zooplankton in the Bay of Fundy, Canada. Canadian J. of Zoology. 67(6): 1411-1420.

National Marine Fisheries Service Northeast Regional Office (NMFS NERO). 2011. Biological Opinion regarding continued operations of the Oyster Creek Nuclear Generating Station, New Jersey. Signed November 21, 2011. 120 pp.

National Marine Fisheries Service. 2011. Final Recovery Plan for the Sei Whale (Balaenoptera borealis). National Marine Fisheries Service, Office of Protected Resources, Silver Spring, MD. 107 pp.

National Marine Fisheries Service. 2010. Recovery plan for the fin whale (Balaenoptera physalus). National Marine Fisheries Service, Silver Spring, MD. 121 pp. Available online at: http://www.nmfs.noaa.gov/pr/pdfs/recovery/finwhale.pdf.

NMFS. 1998. Unpublished. Draft recovery plans for the fin whale (*Balaenoptera physalus*) and sei whale (*Balaenoptera borealis*). Prepared by R.R. Reeves, G.K. Silber, and P.M. Payne for the National Marine Fisheries Service, Silver Spring, Maryland. July 1998.

NMFS Northeast Fisheries Science Center. 2010. 50th Northeast Regional Stock Assessment Workshop (50th SAW) Assessment Report. US Dept Commerce, Northeast Fish Sci Cent Ref Doc. 10-17; 844 p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026, or online at http://www.nefsc.noaa.gov/nefsc/publications/.

NMFS Office of Protected Resources (NMFS OPR). 2012. Status of Cetacean Species. Online at: http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/

NMFS and USFWS (U.S. Fish and Wildlife Service). 2007a. Kemp's ridley sea turtle *(Lepidochelys kempii)* 5 year review: summary and evaluation. Silver Spring, Maryland: National Marine Fisheries Service. 50 pp.

NMFS (National Marine Fisheries Service) and USFWS (U.S. Fish and Wildlife Service). 2007b. Green sea turtle (*Chelonia mydas*) 5 year review: summary and evaluation. Silver Spring, Maryland: National Marine Fisheries Service. 102 pp.

NMFS and USFWS. 1998. Endangered Species Consultation Handbook. Available Online at: http://sero.nmfs.noaa.gov/pr/esa/pdf/Sec%207%20Handbook.pdf

Niklitschek, J. E. 2001. Bioenergetics modeling and assessment of suitable habitat for juvenile Atlantic and shortnose sturgeons (Acipenser oxyrinchus and A. brevirostrum) in the Chesapeake Bay. Dissertation. University of Maryland at College Park, College Park.

Normandeau Associates, Inc. 1977. Thermal Studies of Backwashing Operations at Pilgrim Station During July 1977. Prepared for Boston Edison Company, Boston, Massachusetts. 82 p. (NRC ADAMS No. ML061560291).

Normandeau. 2011a. Icthyoplankton Entrainment Monitoring at Pilgrim Nuclear Power Station: January – December 2010. Submitted to Entergy by Normandeau Associates, Inc. April 27, 2011. 323 pp.

Normandeau. 2011b. Impingement of Organisms on the Intake Screens at Pilgrim Nuclear Power Station: January – December 2010. Submitted to Entergy by Normandeau Associates, Inc. April 22, 2011. 35 pp.

Nuclear Regulatory Commission (NRC). 2011. Generic Environmental Impact Statement for License Renewal of Nuclear Plants: Regarding Seabrook Nuclear Power Station - Draft Report (NUREG-1437, Supplement 46).

NRC 2010. Biological Assessment: Salem Nuclear Generating Station Units 1 and 2, Hope Creek Generating Station Unit 1 - License Renewal. Submitted to NMFS December 2010. 54 pp. (NRC ML103350271).

Nuclear Regulatory Commission (NRC). 2006. Generic Environmental Impact Statement for License Renewal of Nuclear Plants: Regarding Pilgrim Nuclear Power Station - Draft Report (NUREG-1437, Supplement 29).

Nuclear Regulatory Commission (NRC). 2007. Generic Environmental Impact Statement for License Renewal of Nuclear Plants: Regarding Pilgrim Nuclear Power Station - Final Report (NUREG-1437, Supplement 29)

Nuclear Regulatory Commission (NRC). 1996. Generic Environmental Impact Statement for License Renewal of Nuclear Plants: Regarding Pilgrim Nuclear Power Station - Final Report (NUREG-1437).

Pace, R.M. III and R. Merrick. 2008. Northwest Atlantic Ocean Habitats Important to the Conservation of North Atlantic Right Whales (Eubalaena glacialis). NEFSC Ref. Doc. 08-07.

Scherer, M. 2012. Affidavit before the US Nuclear Regulatory Commission. 45 pp.

Shoop, C.R. and R.D. Kenney. 1992. Seasonal Distributions and Abundances of Loggerhead and Leatherback Sea Turtles in Waters of the Northeastern United States. Herpetological Monographs, 6: 43-67.

Spotila, J.R., M.P. O'Connor, and F.V. Paladino. 1997. Thermal Biology. Pp. 297-314 In: The Biology of Sea Turtles. Lutz, P., and J.A. Musick, eds. CRC Press, New York. 455 pp.

Stamieszkin, K., L. Ganley, C. Mayo, *et al.* 2010. Surveillance, Monitoring and Management of North Atlantic Right Whales in Cape Cod Bay and Adjacent Waters – 2010: Final Report. Provincetown Center for Coastal Studies. 31 pp. Available online at: http://www.mass.gov/dfwele/dmf/programsandprojects/rwhale10.pdf

Stein, A. B., K. D. Friedland, and M. Sutherland. 2004a. Atlantic sturgeon marine distribution and habitat use along the northeastern coast of the United States. Transactions of the American Fisheries Society 133: 527-537.

Stein, A. B., K. D. Friedland, and M. Sutherland. 2004b. Atlantic sturgeon marine bycatch and mortality on the continental shelf of the Northeast United States. North American Journal of Fisheries Management 24: 171-183.

Thompson, GR. 2006. Risks and Risk-Reducing Options Associated with Pool Storage of Spent Nuclear Fuel at the Pilgrim and Vermont Yankee Nuclear Power Plants. Cambridge, Massachusetts: Institute for Resource and Security Studies, 25 May 2006.

TRAC. 2010. Atlantic Mackerel in the Northwest Atlantic. TRAC Status Report 2010/01.

TRAC. 2009. Gulf Of Maine-Georges Bank Herring Stock Complex. TRAC Status Report 2009/04.

TEWG (Turtle Expert Working Group). 2007. An assessment of the leatherback turtle population in the Atlantic Ocean. NOAA Technical Memorandum NMFS-SEFSC-555, 116 pp.

Voznesensky, M., PH Lenz, C. Spanings-Pierrot, and DW Towle. 2004. Genomic approaches to detecting thermal stress in Calanus finmarchicus (Copepoda: Calanoida). Journal of Experimental Marine Biology and Ecology 311: 37-46.

Waring, G.T., E. Josephson, K. Maze-Foley, Rosel, P.E. (eds). 2010. US Atlantic and Gulf of Mexico marine mammal stock assessments -- 2010. NOAA Tech Memo NMFS NE 219; 598 p. Available online: http://www.nefsc.noaa.gov/publications/tm/tm219/.

Werme, C, AC Rex, MP Hall *et al.* 2011. 2010 outfall monitoring overview. Boston: Massachusetts Water Resources Authority. Report 2011-16. 75p.

Willis, K. 2007. Thermal tolerance in congeneric Calanus: Implications for biogeographic distribution and ecosystem function in response to global warming. Scottish Association for Marine Science. 5 pp. Available online at: http://arcfac.npolar.no/pdf/Project_Reports/ID66_Willis_summary_rprt2007.pdf.

Wishner, Karen F., E. Durbin, A. Durbin, M. Macaulay, H. Winn, R. Kenney. 1988. Copepod patches and right whales in the Great South Channel off New England.Bulletin of Marine Science. 43(3):825-844.

Ziegeweid, J.R., C.A. Jennings, and D.L. Peterson. 2008a. Thermal maxima for juvenile shortnose sturgeon acclimated to different temperatures. Environmental Biology of Fish 3: 299-307.

Ziegeweid, J.R., C.A. Jennings, D.L. Peterson and M.C. Black. 2008b. Effects of salinity, temperature, and weight on the survival of young-of-year shortnose sturgeon. Transactions of the American Fisheries Society 137:1490-1499.