UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

OFFICE OF THE
GENERAL COUNSEL

May 22, 2012

Administrative Judge
Ann Marshall Young, Chair
Atomic Safety and Licensing Board Panel
Mail Stop T-3F23
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Administrative Judge
Paul B. Abramson
Atomic Safety and Licensing Board Panel
Mail Stop T-3F23
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Administrative Judge
Richard F. Cole
Atomic Safety and Licensing Board Panel
Mail Stop: T-3F23
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

In the Matter of
Entergy Nuclear Generation Company and
Entergy Nuclear Operations, Inc.
(Pilgrim Nuclear Power Station)
Docket No. 50-293-LR; ASLBP No. 06-848-02-LR

Dear Administrative Judges:

This letter is an update to the NRC staff's April 19, 2012 response to the Board's Inquiry (Regarding Information on Expected NMFS ESA Determination), dated April 18, 2012, requesting that the NRC staff (Staff) provide a copy of the Endangered Species Act (ESA) informal consultation from the National Marine Fisheries Service (NMFS), if received, or, in the alternative, an estimate of the anticipated date of receipt.

Please find attached hereto a copy of the ESA informal consultation letter dated May 17, 2012 from the NMFS. The NMFS acknowledged that the continued operation of Pilgrim under the terms of a renewed operating license is not likely to adversely affect any listed species under NMFS jurisdiction. The NMFS letter further provided justification concluding consultation.

By copy of this letter, I am serving a copy of the NMFS letter dated May 17, 2012 on the service list.

Sincerely,

Susan L. Uttal
Counsel for NRC Staff

ENCLOSURE:
As stated

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

MAY 17 2012

Andrew S. Imboden, Chief
Environmental Review and Guidance Update Branch
Division of License Renewal
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
MS T-11 F1
Washington, DC 20555-0001

Re: Pilgrim Nuclear Power Station

Dear Mr. Imboden,

The Nuclear Regulatory Commission (NRC) is proposing to issue a renewed Operating License to Entergy Corp. for their Pilgrim Nuclear Power Station (Pilgrim). Pilgrim is located on the western shore of Cape Cod Bay in the Town of Plymouth, Plymouth County, Massachusetts. The NRC prepared a Biological Assessment (BA) in 2006 which evaluates the effects of the proposed license renewal on whales and sea turtles listed as threatened or endangered by NOAA's National Marine Fisheries Service (NMFS). In 2012, in response to the listing of five Distinct Population Segments (DPS) of Atlantic sturgeon, you prepared a supplemental BA to consider effects of operations on Atlantic sturgeon. You have also considered effects to these species in your 2006 Draft Supplemental Environmental Impact Statement (SEIS) and your 2007 final SEIS. A conference call was held on March 22, 2012, to discuss the status of the consultation because we had significant confusion regarding NRC's determination of effects.

In the species by species discussion in the 2006 BA, NRC concludes that the continued operation of Pilgrim would have no effect on each of the ten species considered; the conclusion of the BA states, "staff has identified ten[1] Federally listed endangered or threatened species that are under full or partial NMFS jurisdiction, that have a reasonable potential to occur in the vicinity of PNPS, and, therefore, may be affected by continuing operations of PNPS... the staff has determined that continued operation of PNPS for an additional 20 years would not have any adverse impact on any threatened or endangered marine aquatic species" (NRC 2006 and NRC 2007 at E-73). The FSEIS states, "staff concludes that continued operation of PNPS during the license renewal term is not likely to adversely affect any Federally listed marine aquatic species" (NRC 2007 at p. 4-64). Your February 29, 2012, letter transmitting the supplemental BA and the supplemental BA itself state that you have determined the continued operation of Pilgrim will have no effect on Atlantic sturgeon.

[1] In the FEIS and 2006 BA, NRC considered loggerhead, green, leatherback and Kemp's ridley sea turtles and sei, fin, North Atlantic right, humpback and sperm whales and shortnose sturgeon.

On the March 22, 2012 conference call, your staff confirmed that NRC believes the continued operation of Pilgrim will have "no effect" on any NMFS listed species. As discussed with your staff on a March 22, 2012 conference call, we do not agree with your "no effect" determination. As we also discussed, informal consultation would be appropriate in this situation. Consultation is required when an action "may affect" listed species and/or critical habitat. Consultation may be concluded informally if the action "may affect, but is not likely to adversely affect" listed species and/or critical habitat. A "not likely to adversely affect" conclusion is appropriate when effects are wholly beneficial, insignificant or discountable. 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 have reviewed the available information and do agree that the continued operation of Pilgrim may affect, but is not likely to adversely affect any species listed as threatened or endangered by NMFS. We have also considered whether the continued operation of Pilgrim may affect critical habitat designated for the Northern right whale in 1994 (herein after, right whale critical habitat). In this letter, we provide our justification for concluding consultation informally.

Description of the Facility and Proposed Action

You are proposing to issue a renewed Operating License for the Pilgrim facility. The plant was constructed and licensed in 1972, and the current license expires on June 8, 2012. The facility is currently owned and operated by the Entergy Corporation. The renewed license would authorize the continued operation of the facility until June 8, 2032. 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 2032.

The Pilgrim facility operates a single reactor unit with a boiling water reactor and turbine generator. The cooling and service water systems operate as a once-through cooling system, with Cape Cod Bay being the water source. Seawater is withdrawn from the Bay through an intake embayment formed by two breakwaters. Two pumps provide a continuous supply of condenser cooling water.

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 Massachusetts. 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 Massachusetts through the NPDES program.

Pilgrim 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 Pilgrim 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 Pilgrim 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 FSEIS. The NPDES permit for this facility was last issued in 1991 and modified in 1994. This permit expired in 1996 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 expiration of the existing operating license. As such, we have considered the effects of continued operation of Pilgrim under the terms of a new operating license and the existing modified 1991 NPDES permit (EPA 1991 and EPA 1994).

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 Pilgrim facility is located on land and includes two land based transmission lines. 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 Cape Cod Bay where effects of the thermal plume are experienced. Based on the available information, the largest area measured with increased water temperatures was a surface area of 216 acres with a temperature of 3°C above ambient; however, models predict that the maximum surface area (extending no deeper than five feet from the surface) with a temperature of 1°C above ambient can encompass an area as large as 3,000 acres (this 3,000 acre area extends approximately 7,000 feet (approximately 1.3 miles) from the discharge canal). At the bottom, the largest area that is likely to experience increased temperatures is 8.4 acres. 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.

Individual North Atlantic right whales (*Eubalaena glacialis*) occur in Cape Cod Bay nearly year round; however, the vast majority of sightings occur from January – April (Pace and Merrick 2008). 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, 7,498 were in Cape Cod Bay (Pace and Merrick 2008). Right whales are most common in eastern Cape Cod Bay, although individuals have been sighted throughout the Bay. 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 three sightings in Cape Cod Bay in June; two sightings of three whales in July, none in August, one in September, one in October, three in November (likely the same individual sighted on three consecutive days in 2011), and four in December. Of the thousands of recorded sightings of hundreds of individual right whales in Cape Cod Bay since 1997, we have identified six sightings records (five definite, one probable) of 12 right whales within approximately two miles of the Pilgrim facility. Four of the six sightings were in April (2008, 2010 and 2012), one was in May and one was in December. The seasonal presence of right whales in Cape Cod Bay 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)

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 in Massachusetts waters 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). Humpback whales are known to occur in Cape Cod Bay and could be present in the action area. We have reviewed sightings data plotted in the OBIS-SEAMAP[2] database. The majority of humpback whale sightings are in eastern Cape Cod Bay. Of 21,472 records of 36,268 individual sightings of humpback whales recorded in this database, only two are within five miles of Pilgrim.

Fin whales (*Balaenoptera physalus*) are also known to be present in Cape Cod Bay 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. Of 51,942 records of 61,874 individual sightings, there are only six records of 16 individual fin whales within five miles of Pilgrim. There are no sightings recorded in the database closer than 3 miles from the facility.

NRC's BA and EIS 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

[2] 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).

continental shelf edge, over the continental slope, and into mid-ocean regions. Sightings of sei whales in Cape Cod Bay are extremely rare. Of 9,172 sightings of sei whales recorded in OBIS-SEAMAP database, only three are records of sei whales in Cape Cod Bay; all three sightings were on the extreme eastern edge of the Bay near Provincetown. These sightings were in 1967 and 1976. Based on the extremely rare occurrence of sei whales and their known habitats (the continental shelf and other offshore waters), we do not expect sei whales to occur in the action area. Of the 23,929 sightings of sperm whales in the OBIS-SEAMAP database, none were in Cape Cod Bay. Based on the lack of known occurrences of sperm whales in Cape Cod Bay and their known habitats (continental shelf edge, over the continental slope, and into mid-ocean regions), we do not expect sperm whales to occur in the action area.

Certain New England waters were designated as critical habitat for Northern right whales[3] 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 discharge canal is approximately 1.5 miles from the area in Cape Cod Bay designated as critical habitat.

Sea turtles are seasonally present in Cape Cod Bay. The species that occur in Cape Cod Bay and are likely to 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 kempi*) sea turtles, endangered leatherback sea turtles (*Dermochelys coriacea*) and endangered green sea turtles *(Chelonia mydas)*. There are no estimates of the numbers of sea turtles that are present seasonally in Cape Cod Bay generally or the action area specifically. Few researchers have reported on the density of sea turtles in Northeastern waters; however, this information is available from one source (Shoop and Kenney 1992). Shoop and Kenney (1992) used information from the University of Rhode Island's Cetacean and Turtle Assessment Program (CETAP[4]) as well as other available sightings information to estimate seasonal abundances of loggerhead and leatherback sea turtles in northeastern waters. As illustrated in Figure 3 of the Shoop and Kenney paper, the aerial and shipboard surveys covered Cape Cod Bay, including the portion of the Bay we have defined as the action area. The authors calculated overall ranges of abundance estimates for the summer of 7,000-10,000 loggerheads and 300-600 leatherbacks present in the study area from Nova Scotia to Cape Hatteras. Using the available sightings data (2841 loggerheads, 128 leatherbacks and 491 unidentified sea

[3] 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.

[4] The CETAP survey consisted of three years of aerial and shipboard surveys conducted between 1978 and 1982 and provided the first comprehensive assessment of the sea turtle population between Nova Scotia, Canada and Cape Hatteras, North Carolina.

turtles), the authors calculated density estimates for loggerhead and leatherback sea turtles (reported as number of turtles per square kilometer). These calculations resulted in density estimates of 0.00164 – 0.510 loggerheads per square kilometer and 0.00209 – 0.0216 leatherbacks per square kilometer. It is important to note, however, that this estimate assumes that sea turtles are evenly distributed throughout the waters off the northeast, even though Shoop and Kenney report several concentration areas where loggerhead or leatherback abundance is much higher than in other areas. Further, despite high observation effort in Cape Cod Bay in the spring, summer and fall, no sea turtles were observed in Cape Cod Bay. Additionally, the report only considered the presence of leatherback and loggerhead sea turtles. The Shoop and Kenney abundance estimates, despite considering only the presence of loggerhead and leatherback sea turtles, likely overestimates the number of sea turtles present in the action area. This is due to the assumption that sea turtle abundance will be even throughout the Nova Scotia to Cape Hatteras study area. However, sea turtles occur in high concentrations in several areas outside of the action area, and the inclusion of these concentration areas in the density estimate likely overestimates the number of sea turtles in the action area. Therefore, we expect even lower abundance and density of sea turtles in the action area than the coast wide estimates provided in Shoop and Kenney (1992).

The maximum size of the area warmed by the thermal plume is 3,000 acres (approximately 12 square kilometers), using the density estimates of Shoop and Kenney (1992), we would expect no more than 6 leatherback sea turtles and no more than 1 loggerhead sea turtle to be present in the action area at a given time during the summer. Because Kemp's ridleys and greens are less common than leatherbacks and loggerheads in Massachusetts, we would expect fewer individuals of these species to be present in the action area. For reference, there are approximately 60,000 adult loggerheads in the NWA DPS, with an additional unknown number of juveniles and subadults; the most recent population size estimate for the North Atlantic alone is 34,000-94,000 adult leatherbacks (TEWG 2007); current population estimates for Kemp's ridleys are approximately 7-8,000 adult females with additional unknown numbers of males and younger age classes (NMFS and USFWS 2007); for green sea turtles there are an estimated 17,402-37,290 nesting females per year (NMFS and USFWS 2007b) with additional males and younger age classes. Sightings data indicate that leatherback sea turtles are the most common species of sea turtle in Massachusetts waters, including Cape Cod Bay, followed by loggerheads, with fewer Kemp's ridley and green sea turtles. Sea turtles are typically present in Massachusetts waters from June through October; however, cold stunned turtles may continue to strand on Massachusetts beaches through January. Sea turtles in the action area are likely to be foraging or migrating.

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 Pilgrim 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 Cape Cod Bay generally or the action area specifically. Entergy has reported the capture of two Atlantic sturgeon (1982 and 2009[5]) in surveys associated with assessing impacts of Pilgrim on the environment. The capture of Atlantic sturgeon in trawl surveys carried out by the Massachusetts Division of Marine Fisheries in Cape Cod Bay is rare, with only one capture recorded to date. Similarly, few Atlantic sturgeon have been reported as bycatch in commercial fisheries operating in Cape Cod Bay (Stein *et al.*. 2004).

NRC also considers shortnose sturgeon (*Acipenser brevirostrum*) in their BA and FSEIS. However, shortnose sturgeon are not known to occur in the action area. Shortnose sturgeon are present in certain large rivers along the U.S. Atlantic coast. The nearest rivers to Pilgrim that are known to contain shortnose sturgeon is the Merrimack River (MA) and Connecticut River (CT/MA). While in the Gulf of Maine, shortnose sturgeon have been documented to make nearshore coastal migrations between neighboring rivers (i.e., the Kennebec and Penobscot Rivers, both in Maine), this behavior is not known to occur outside of this region. No shortnose sturgeon have been documented in Cape Cod Bay and we do not expect this species to be present in the action area. Therefore, this species will not be considered further in this consultation.

EFFECTS OF THE ACTION

Below, we consider the effects of the continued operation of Pilgrim under the terms of a new operating license on listed species and critical habitat. We consider the effects of water withdrawal (impingement or entrainment of listed species and their prey) and effects of the discharge of effluent (exposure to pollutants, including heat, and effects on prey). In addition to considering information presented in the 2006 DSEIS and the 2007 FSEIS, we have considered information presented in NRC's Generic EIS for relicensing, the most recent impingement and entrainment reports (Normandeau 2011a and 2011b) for Pilgrim, and other sources of information on listed species and their prey as cited below.

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.

[5] One fish measuring 82.8 cm (2.7 feet) was caught in a gill net operated by the Mass. Division of Marine Fisheries in November 1982. A second fish measuring 180 cm (5.9 feet) was caught in a bottom trawl survey conducted by Normandeau Associates in May 2009 (Scherer 2012).

Entrainment sampling was initiated in 1974 and was initially conducted twice per month from January to February and from October to December and conducted weekly from March through September. During these events, sampling was conducted in triplicate. Beginning in 1994, during the January to February and October to December time periods, samples have been collected every other week on three separate days for a total of approximately six samples per month. During the March through September time frame, three separate samples have been collected every week for a total of approximately 12 samples per month (NRC 2007).

A rack system is in place in front of the intakes to screen out large debris; this consists of vertical bars spaced 3-inches apart. There is also a ¼-inch by ½-inch mesh traveling screen system (NRC 2007). To be entrained in the facility, an organism must be able to pass through this 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. Impingement sampling has been ongoing since 1980 and consists of monitoring three scheduled screen-wash periods each week throughout the year. Monitoring occurs for 30 to 60 minutes at a time (NRC 2007).

Atlantic sturgeon
Fish that are narrower than 3-inches may pass through the trash bars and become impinged on the traveling screens. Fish with body widths larger than 3-inches could become impinged on the trash racks. Information on length-width relationships for sturgeon indicates that sturgeon longer than 85cm would be excluded from a 4-inch opening (UMaine, unpublished data). While we do not have information on the body lengths that would have widths sufficiently large to prevent passage through a 3-inch opening, because fish get wider as they get longer, we expect that the length of fish that could possibly pass through a 3-inch opening would be smaller than 85 cm. Atlantic sturgeon do not leave their natal rivers until they are approximately 76 cm (ASSRT 2007); thus, the only fish susceptible to impingement on the traveling screens would be those that are 76 – 85 cm long, which would be a subadult given that they mature at approximately 150cm (ASSRT 2007). Atlantic sturgeon attain lengths of approximately 200cm (Colette and Klein-MacPhee 2002).

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 Pilgrim's racks are approximately 1.0 feet per second (fps) or less, depending on tide and operations; through-screen velocities on the traveling screen are no higher than 2.0 feet per second (NRC 2007). In order for impingement to happen, a fish must be overcome by the intake or through-screen 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, Atlantic sturgeon should also 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. No Atlantic sturgeon have been documented as impinged at Pilgrim.

As a condition of their existing license, Entergy must report to NRC any observations of listed species. No whales or sea turtles have been observed impinged at the Pilgrim intakes (NRC 2007). We have considered whether there is the potential for future impingement at Pilgrim. 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 3-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 Pilgrim intakes. No sea turtle impingements have been recorded at any other power plant with a cooling water intake in New England, including the Seabrook (NH) 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 Pilgrim intakes; the lack of any impingement in the past supports this conclusion.

Based on this analysis, the impingement or entrainment of any whales, sea turtles, 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, DEIS and FEIS; no Atlantic sturgeon, whales or sea turtles have been observed as impinged or entrained at the intakes.

Impingement and Entrainment - Effects on Prey

NRC reports in the FEIS that 73 species of fish and 18 taxa of invertebrates have been recorded during impingement sampling since 1980 (NRC 2007). NRC also reports that losses due to impingement from Pilgrim were less than one percent of the population for each of the recorded impinged species, with the exception of cunner and rainbow smelt. Below, we consider the effects of the loss of potential prey species due to impingement or entrainment at Pilgrim for whales, sea turtles and Atlantic sturgeon that may be foraging in the action area and in Cape Cod Bay.

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). Right whales forage in Cape Cod Bay from January – April; this area is known to have high densities of copepods during this time of year (Pace and Merrick 2008).

Because of their small size, copepods would be entrained at Pilgrim rather than impinged against the intake screens. Some entrained copepods are likely to die as they travel through the plant due to thermal stress and exposure to chlorine. Entergy reports that studies conducted in 1984 indicate that mortality of entrained zooplankton is approximately 5% during most operating conditions, with an additional loss of 8.3% of entrained zooplankton that are exposed to chlorine. Thus, more than 85% of entrained zooplankton are likely to survive entrainment (Bridges and Anderson 1984).

A study on the effect of Pilgrim's operations on zooplankton was undertaken in the 1970s, after Pilgrim began operating. In a study conducted from August 1973 through December 1975, duplicate samples were taken monthly at mid-depth near the Pilgrim intake and discharge and at various depths at offshore stations. Copepods, especially *Acartia clausi* and *Acartia tonsa*, dominated the samples. *Pseudocalanus minutus* occurred in moderate abundances (approximately 1,000 individuals/m3) every month. Reports indicate that statistical evaluation of the mean densities of the copepod species observed did not reveal any differences between sampling stations (ENSR 2000).

NRC has indicated that, other than the studies cited above, no information on the entrainment of zooplankton generally or copepods specifically is available for Pilgrim. 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).

Because we do not have information on the number of copepods entrained at Pilgrim that we can compare to the volume of copepods in Cape Cod Bay, which would give us information on the relative loss of copepods, we have considered other information on zooplankton and copepods in Cape Cod Bay. We expect that if the continued operation of Pilgrim was having an effect on the zooplankton community in Cape Cod Bay, that there would be a negative trend in zooplankton and copepod abundance in the Bay since Pilgrim became operational. However, as explained below, long term studies of zooplankton and copepods in Cape Cod Bay have not found any negative trend in copepod abundance.

The zooplankton community in Cape Cod Bay has been monitored by the Massachusetts Water Resources Authority (MWRA) since 1992, both near the MWRA outfall and at farfield stations, including stations in Cape Cod Bay. As most recently reported in 2010, there have been no changes in the zooplankton community at any of the stations beyond normal ecological fluctuations (Werme *et al.*. 2011).

The abundance of the three primary copepod that right whales feed on is variable in Cape Cod Bay, both monthly and annually (Stamieszkin *et al.*. 2010); a review of data on copepods collected in Cape Cod Bay from 2003-2010 compiled by Stamieskin *et al.*. (2010) reveals no trends of enrichment or decline for any of the three taxa studied (*Calanus*, *Pseudocalanus* and *Centropages*). Together, these studies support NRC's determination that continued operations of Pilgrim have not destabilized or negatively impacted the zooplankton community in Cape Cod Bay.

We have conducted a literature search to determine if there is any information on the effects of other nuclear power plants with once through cooling systems on zooplankton, including copepods. A peer reviewed paper was found which documented an 8-year study of zooplankton entrainment at a nuclear facility on Lake Michigan (Evans *et al.*. 1986). The authors concluded that the studies showed a small percentage of entrained zooplankton were actually killed as a result of passage through the condenser cooling system and that these small losses were not able to be detected at the lake. However, this study occurred in a fresh water system with different species of zooplankton (and different species of copepods) and operations of the Lake Michigan power plant and Pilgrim may be different. The Bridges and Anderson (1984) study at Pilgrim on zooplankton mortality does reach similar conclusions regarding zooplankton mortality resulting from entrainment.

Studies presented by Huggett and Cook (1991) consider effects of entrainment of zooplankton at a nuclear power facility on the coast of South Africa. While there are right whales off the coast of South Africa, this study did not consider effects to right whales or other species that feed on copepods. Mortality rates for entrained copepods were approximately 22%; however, the copepods discussed were not the species that right whales in Cape Cod Bay forage on. The authors concluded that plankton entrainment at the Koeberg facility was not considered to be "particularly detrimental to the marine environment" mainly because of the localized area affected (no more than 1 km from the mouth of the outfall canal), the rapid dispersion of heat and chlorine, the rapid regeneration times of phytoplankton and some zooplankton, and the potential for recruitment from the surrounding area.

Extensive pre- and post-operation monitoring has occurred at the Seabrook Nuclear Power Station in New Hampshire. Seabrook withdraws approximately 600 million gallons of water per day (MGD; NRC 2011) (Pilgrim withdraws a maximum of 510 MGD). As reported in the DEIS prepared by NRC for relicensing of Seabrook, 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.

The available information indicates that most (greater than 85%) entrained zooplankton will survive entrainment at Pilgrim. We expect that some of the zooplankton that are killed will be copepods and that some of those copepods may be of the three types that are preferred by right whales. However, studies conducted at Pilgrim, and at other nuclear power plants, indicate that any losses of copepods are not detectable outside of natural variability. Further, information gathered from several longterm monitoring programs designed to document changes in the zooplankton community in Cape Cod Bay, does not indicate that there have been any reductions in copepod abundance in the Bay. If Pilgrim was having more than an insignificant effect on copepod populations within the Bay, we expect that these studies would have detected a negative trend over time.

While there may be significant annual variability in copepod abudance and associated right whale foraging in the Bay, which is thought to be due at least party to weather and oceanic conditions (e.g., differences in 2010 as compared to other years are thought to be due to the changes in the Western Maine Coastal Current (Stamieszkin *et al.*. 2010), the available information does not suggest that there has been a long-term negative trend in copepod abundance or distribution or right whale abundance or distribution since the Pilgrim facility became operational that may be attributable to operations of the facility. While some copepods are likely lost to entrainment at Pilgrim each year and these losses, if they were the right species and occurred at a time of year when right whales were present, would reduce the amount of prey available to right whales, however 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[6], mackerel and sand lance. 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 Pilgrim (NRC 2007 and Normandeau 2011a and 2011b).

Atlantic mackerel (*Scomber scombrus*) have been occasionally impinged at Pilgrim. From 1980-2010, mackerel have been impinged in seven years with a mean annual impingement of seven individuals. As described in the 2010 entrainment report (Normandeau 2011a), Atlantic mackerel "equivalent adults" attributable to entrainment in 2010 amounted to 316 age-one fish or 114 age-three fish based on two sets of survival values. The northwest Atlantic mackerel spawning stock biomass was 96,968 metric tons in 2008 with average recruitment of 566 million age-one fish from 1985-2009 (TRAC 2010). While the annual loss of Atlantic mackerel at Pilgrim 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 Pilgrim. The mean number of Atlantic herring impinged at Pilgrim (1990-2004) is 2,069 individuals per year. The most recent (Normandeau 2011a) report for entrainment at Pilgrim indicates that the equivalent adult value of Atlantic herring entrained or impinged at Pilgrim would account for about 0.01 percent of the spawning stock by biomass. 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 652,000 metric tons; the 2005 year class was approximately 3.3 billion individuals. While the loss of Atlantic herring at Pilgrim 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*) is impinged in only some years and at very low numbers (Normandeau 2011b). Larval sand lance are entrained seasonally at Pilgrim (Normandeau 2011a); the long term annual mean number entrained is 3,854 (Normandeau 2011a). 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. While the loss of sand lance at Pilgrim results in fewer fish that are available for large whales to eat, this loss represents an extremely small percentage of the sand lance available to these species. Because of this, any effects to foraging whales will be insignificant.

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[6] 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.

Humpback whales may feed occasionally on pollock and haddock. Entergy reports the impingement of a total of 15 haddock (all in 2007) from 1980-2010 (Normandeau 2011b). Haddock eggs and larvae are also occasionally entrained at Pilgrim. The annual entrainment estimate for haddock eggs and larvae at Pilgrim ranges between 0 and 89,926 eggs and 0 and 178,892 larvae (ENSR 2000). Entergy reports that haddock eggs were only observed once between 1989 and 1998 and haddock larvae were only observed in four of these 10 years. 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 eggs and larvae at Pilgrim represents an extremely small percentage of the haddock available to whales.

Entergy reports the impingement of an average of 65 pollock annually from 1980-2010. The average number of estimated pollock eggs and larvae entrained annually at Pilgrim between 1989 and 1998 is 26,044 and 47,364 respectively (ENSR 2000). Pollock eggs were only observed twice between 1989 and 1998 and pollock larvae were only observed four of the 10 years (ENSR 2000). Estimates of pollock abundance were 196,000 metric tons in 2009. The loss of pollock at Pilgrim represents an extremely small percentage of the sand lance available to these species. Because of this, any effects to foraging whales will be insignificant.

Other small schooling fish that are impinged or entrained at Pilgrim 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).

Green sea turtles

Green sea turtles feed primarily on sea grasses and may also feed on algae. Sea grasses are immobile and rooted in the substrate; they can only be impinged at the intakes if they have become uprooted due to some other cause, such as a storm. The continued operation of Pilgrim does not cause the loss of any seagrasses due to impingement or entrainment. Green sea turtles are not known to feed on Irish moss (K. Sampson[7], personal communication), the red seaweed that has been identified as being impinged and entrained (spores) at Pilgrim. As the species that green sea turtles forage on are not affected by impingement or entrainment, we do not anticipate any loss of green sea turtle forage items due to impingement or entrainment.

Loggerhead and Kemp's ridley sea turtles

Loggerhead turtles feed on benthic invertebrates such as gastropods, mollusks and crustaceans. Kemp's ridleys primarily feed on crabs, with a preference for portunid crabs including blue crabs. Pilgrim impinged a mean of 273 cancer crabs (*Cancer* spp.) per year from 1980 through 2010 based on extrapolated annual totals (Normandeau 2011b). However, annual impingement rates have varied widely. Pilgrim impinged cancer crabs in only two years from 1980 to 1999, but from 2000 to 2010, Pilgrim impinged cancer crabs nine out of the 10 years (Normandeau 2011b). There is similar variability in the number of other invertebrates, including other crab species, impinged at Pilgrim each year, with no individuals impinged in many years but some years having multiple individuals impinged. In some years, several thousand individual invertebrates, including crabs, are impinged (Normandeau 2011b). However, all of these species

[7] Personal communication, April 2012 with Kate Sampson, NMFS NERO Sea Turtle Stranding Coordinator.

are widely distributed with populations of at least millions of individuals and any loss due to impingement at Pilgrim represents an extremely small percentage of the individuals in the action area and in Cape Cod Bay or throughout their range. While the loss of benthic invertebrates, including crabs, at Pilgrim 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 turtles
Leatherback sea turtles feed exclusively on jellyfish. The most recent impingement report for Pilgrim (Normandeau 2011b) indicates that Pilgrim impinged 744 jellyfish (Phylum Cnidaria) in 1981 and 940 jellyfish in 1983 based on extrapolated totals. However, no jellyfish have appeared in impingement samples since 1983. Because the impingement of jellyfish is rare, and the numbers of jellyfish impinged in the past is low in relation to overall population levels, we expect that in the 20 years of continued operations, there will be the occasional impingement of low numbers of jellyfish. Any jellyfish lost at Pilgrim represent a reduction in available prey for leatherbacks foraging in Cape Cod Bay; however, because the loss will be limited to occasional instances and only a small number of individuals, which equates to a miniscule percentage of the overall number of jellyfish available to leatherbacks, the effect on foraging leatherbacks will be insignificant.

Atlantic sturgeon
Atlantic sturgeon feed on benthic invertebrates and occasionally on sand lance. Effects to sand lance are considered above; because the loss of sand lance at Pilgrim is an extremely small percentage of the biomass of sand lance, effects to foraging Atlantic sturgeon from this loss are will be insignificant. NRC states that monitoring of the benthic environment near Pilgrim indicates that effects related to Pilgrim can only be detected in a very small area (less than 1 acre; NRC 2007). Any benthic invertebrates lost at Pilgrim results in fewer individuals that are available for Atlantic sturgeon to eat; however, given the small area where the benthic community is affected (less than 1 acre), any effects to foraging Atlantic sturgeon would be insignificant.

Discharge of heated effluent

Description of the thermal plume
Heated effluent is discharged from the Pilgrim outfalls. Under normal operation, seawater is heated in the condensers to approximately 15 to 17°C above the intake temperature (which ranges annually from 2 to 22°C). The temperature of the discharged water is a function of the temperature of the incoming seawater. From the condensers, water flows through a buried concrete conveyance to the discharge canal. Upon exiting the concrete pipe, discharged water enters a 900-foot-long trapezoidal discharge canal. The NRC has indicated that this thermal plume is rapidly dissipated and is only present in the nearshore area around the facility. The NPDES permit limits the temperature of cooling water discharged from the facility to be no more than 32°F (17.8°C) above ambient, with a maximum limit of 102°F (56.7°C). Studies of the thermal plume occurred in the 1970s and again in the 1990s. Two of the most detailed thermal investigations at PNPS were a 1974 study by the Massachusetts Institute of Technology (MIT

1974), which focused on characterizing the plume based on surface water temperature measurements, and a 1994 study by EG&G (1995), which focused on bottom water temperature measurements to characterize the benthic thermal plume and validate mathematical models to predict bottom plume characteristics (ENSR 2000). At low tide, the turbulent discharge plume is well mixed vertically as it leaves the canal, due in part to the significant downward momentum of the discharge as it spills from the mouth of the discharge canal. The plume remains in contact with the bottom at low tide for up to several hundred meters offshore. At the surface, the plume spreads by mixing with the ambient water. At the bottom the core temperature of the plume drops and its width narrows with distance offshore. As a result, elevated temperatures are present at low tide over a limited area of the bottom near the discharge canal (see detailed discussion below; EG&G 1995). At high tide, the discharge has a much lower velocity and no downward momentum. As a result, the thermal discharge plume rises away from the bottom almost immediately upon leaving the discharge canal (EG&G 1995).

The 1974 study found that the thermal plume is largest during high tide, and that during high tide the plume is essentially confined to the surface layer. The depth of the plume was found to be relatively shallow, with depths ranging from 3 to 8 feet at high tide. The temperature difference (delta T) between ambient water and the thermal plume was found to cover a larger area when ambient temperatures were higher. For example, water with a delta T of 3°C (5.4°F) covered approximately 216 acres in August when the ambient temperature was 17.0°C (62.6°F), but only 14 acres in November when the ambient temperature was 8.5°C (47.3°F). The maximum recorded size of the plume was a 216 acre area that had temperatures 3°C (5.4°F) above ambient from the surface to 4 feet below the surface. The study demonstrated that the size of the plume was influenced by ambient temperatures. In November, when ambient water temperatures were 8.5°C (47.3°F), the largest measured extent of the plume (delta T of 1°C (1.8°F)) was only 56 acres. In July, when the ambient temperature was 11.5°C (52.7°F), the largest measured extent of the plume (delta T of 1°C (1.8°F)) was 138 acres. In all instances, the plume was limited to the area between the surface and 3-8 feet below the surface. The area of the plume was found to decrease rapidly with increasing depth, due to the buoyancy of the plume. Throughout the tidal cycle, the smallest surface areas with elevated temperatures occurred between low water slack tide and peak flood tide, and the largest areas occurred between high water slack tide and peak ebb tide (ENSR 2000 in NRC 2007). Model results suggest that, during worst case conditions, the area where water temperatures will be at least 1°C above ambient could be as large as 3,000 acres. Visual depictions of the area encompassed by this area are not available. However, the delta T 3°C area was illustrated (see MIT 1974). Using this figure and the maximum distance between the 4°C and 3°C isopleths, the 3,000 acre area occupied by the delta T 1°C is predicted to extend approximately 7,000 feet (approximately 1.4 miles) from the discharge canal. For reference, measured from the shoreline at Pilgrim, it is approximately 18.5 miles to the tip of Cape Cod and approximately 18 miles to the southern extent of Cape Cod Bay.

The 1994 study (EG&G 1995) measured the bottom temperature patterns based on time series measurements at 59 locations in the immediate vicinity of the discharge. The maximum offshore extent of the benthic thermal plume at low tide, based on the area of 1°C temperature elevation, did not exceed 170 meters (558 feet) from the mouth of the discharge canal, and its width did not exceed 40 meters (131 feet) at a distance of 80 m (262 ft) offshore. The maximum bottom area covered by the 1°C temperature elevation at low tide was about 1.2 acres; the maximum temperature elevation recorded (increase of 9°C (16.2°F)) was limited to an area of less than 0.13 acres at the bottom. During high tide, there was no discernible temperature increase at any location, even within 50 m of the mouth of the discharge canal. Because the benthic thermal plume study involved measurements taken over a short period of time and the temperatures and extent of the plume were strongly affected by ambient temperatures, the report (EG&G 1995 references in NRC 2007) also considered the potential for more extreme thermal plume characteristics under worst case conditions. It concluded that extreme bottom temperatures and plume areas could result from a prolonged period of unusually warm weather, spring tide conditions in which the lowest water level can be nearly 1 m (3 feet) below mean water level (MLW), and conditions favorable for downwelling could be produced by warm winds from the north or northeast in summer. The combination of these conditions potentially could result in peak discharge temperatures in excess of 38°C (100.4°F). Given the uncertainty in the area it was estimated that these conditions potentially could result in the thermal plume contacting the bottom over an area about four to seven times the area measured in the study. Using this information, during extreme conditions, the maximum offshore extent of the benthic thermal plume at low tide, based on the area of 1°C temperature elevation, would not exceed 680-1,190 meters from the mouth of the discharge canal, and its width would not exceed 160-280 meters at a distance of 80 meters offshore. The maximum bottom area covered by the 1°C temperature elevation at low tide, would be 4.8-8.4 acres; the maximum bottom area covered by the 9°C temperature elevation would be 0.52-0.91acres at the bottom.

An additional source of heated water discharge at PNPS is backwashing operations; this is used to control biofouling in the condenser tubes. Condenser tubes at Pilgrim are cleaned by backwashing on a one to two week interval, depending on the degree of biofouling; the flow of heated water is reversed so that organisms fouling the condenser tubes and intake structure are killed by the elevated temperatures. The process results in the flow of heated water out of the intake structure and into the intake embayment. The thermal backwashing process generally occurs for approximately 45 to 60 minutes and produces elevated water temperatures averaging approximately 37.8°C (100°F) (NRC 2007). A thermal survey to determine the effects of backwashing operations at Pilgrim found that backwashing results in a relatively thin thermal plume, averaging 3 to 5 feet in depth (water depths in the area are at least 18-24 feet at mean low water), that spreads rapidly from the intake structure across the western end of the intake embayment and along the outer breakwater. The plume completely dissipates within 2-4 hours (Normandeau 1977).

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

Whales

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). All three whale 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). Heated areas are discussed below in terms of acres. For reference, the surface area of Cape Cod Bay is approximately 321,237 acres (1,300 square kilometers; Emberton 1981).

While small numbers of right whales (e.g., less than 3 at a time) can be present in Cape Cod Bay year round, right whales are typically present in the Bay from January – April (Pace and Merrick 2008). During this time of year, mean sea surface temperatures in Cape Cod Bay range from approximately 0-10°C (see Delorenzo Costa *et al.*. 2006). Assuming that right whales may be negatively affected at water temperatures above 21.8°C (the maximum temperature where they have been recorded), to consider direct effects to right 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 21.8°C. During the January – May time period, water would need to be heated at least 11.8°C above ambient to reach this level. The discharge temperature of the effluent is 15-17°C above ambient so even in the winter, water would be discharged at levels potentially above the thermal tolerance of right whales. However, outside of extreme summer conditions, the bottom area where temperatures are greater than 9°C above ambient are less than 0.13 acre (EG&G 1995). Thus, the bottom area that we would expect right whales to avoid would be less than 0.13 acres.

We have information on the size of the thermal plume at the surface when ambient temperatures were 8.5°C and 11.5°C. These conditions are similar to those when whales are present in Cape Cod Bay and are most likely to be present in the action area. As noted above, avoidance by right whales could occur at temperatures of 21.8°C. With ambient temperatures of less than 10°C, right whales are only likely to avoid surface areas with water temperatures warmed at least 11.8°C above ambient. When ambient temperatures were 8.5°C and 11.5°C, the surface area where water temperatures were greater than 7°C and 6°C respectively were 0.1 and 0.5 acres; the areas where water temperature would be 21.8°C or higher would be even smaller. Based on this, the area where water temperatures are potentially high enough for right whales to avoid during the January – May time period are less than 0.13 acres at the bottom and less than 0.5 acres at the surface. As stated previously, most right whale sightings in Cape Cod Bay occurred in the eastern portion of the Bay. With regard to the relatively small subset of right whales in Cape Cod Bay that travel to the western part of the Bay, we expect that right whales would avoid waters heated to above 21.8°C by swimming under or around them. Because the area of the plume that would be avoided is extremely small (less than 0.5 acre, or less than 0.0002% of the surface area of Cape Cod Bay), 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.

Fin and humpback whales could be present in the action area year round but are more likely to be in the action area during the summer months. During the warmest months, ambient temperatures can be as high as 22°C. Given the known distribution of fin and humpback whales in waters of 28 and 32°C respectively, water would need to be heated to at least 6 and 10°C above ambient to be potentially stressful to these species. As evidenced in the discussion for right whales above, during the winter months, this area is extremely small (less than 0.13 acre at the bottom and less than 0.5 acre at the surface).

At conditions of ambient temperature 17°C, the area where temperatures are more than 6°C above ambient (23°C and higher) was measured at 2.6 acres (ENSR 2000). No measurements were made at ambient temperatures over 17°C. However, we also know the size of the area where delta T was 6°C at 11.5°C; in this case, a 50% increase in ambient temperature (11.5°C to 17°C) results in approximately a five-fold increase in the size of the area with a delta T 6°C (0.5 acres to 2.6 acres). Assuming that this relationship is linear, we calculate that the size of the delta T 6°C would be 4.33 times bigger when ambient temperatures are 22°C (i.e., a 1.3 times increase in ambient temperature would result in an approximately 4.33-fold increase in the size of the delta T 6°C area). Thus, we expect the area where surface temperatures would be higher than 28°C to be approximately 11.25 acres (2.6x4.33); the area with surface temperatures of 32°C would be even smaller. Based on this analysis, the surface area where water temperatures would be potentially stressful to humpback and fin whales (i.e., greater than 32°C and 28°C respectively), would be smaller than 11.25 acres (approximately 0.004% of the surface area of Cape Cod Bay).

As discussed in EG&G (1995), during most of the year, the benthic area where water temperatures are more than 9°C above ambient is less than 0.1 acres and the area where water temperatures are more than 1°C above ambient is less than 1 acre. Throughout most of the year, the benthic area that fin and humpback whales would avoid is no more than 1 acre. During certain extreme conditions, the area where water temperature is heated above ambient by 9°C can be as large as 0.91 acres and the area where water temperature is heated above ambient by 1°C can be 8.4 acres. The size of the thermal plume as measured at the delta T 1°C, 5°C, and 9°C isopleths, changes by at least one-third (see Table 5.1-3 in ENSR 2000; e.g., the area at the bottom that is 5°C is approximately 1/3 the size of the area that is 1°C). Thus, we expect that even in the worst case summer conditions, the benthic area that would be avoided by humpback and fin whales would be approximately 3 acres (1/3 the size of the delta T 1°C).

Given that the size of the surface and bottom areas that fin and humpback whales are likely to avoid (no more than 11.25 acres at the surface and 3 acres at the bottom) is small, and avoidance behavior is expected to be limited to swimming around or under the plume, 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. 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 there warmest, the surface area heated to 28°C or higher is approximately 11.25 acres; the benthic area is even smaller (less than 3 acres (see above for calculations)). 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 Cape Cod Bay to determine whether the thermal effluent associated with Pilgrim 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 Pilgrim 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 Pilgrim 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 of tidal influences on the distribution of the thermal plume in the water column (i.e., at low tide, the plume is only at the bottom), there would never be a period longer than 6 hours where warm enough water would be present throughout the water column. When ambient water temperatures are 8.5°C, the area warmed to over 11°C is less than 14 acres (approximately 0.004% of the surface area of Cape Cod Bay) and extends only 4 feet from the surface (see Table 5.1-1 in ENSR 2000); 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 Bay. 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 Pilgrim. 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 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 sturgeon to be exposed to temperatures which are expected to result in behavioral avoidance (28°C). Atlantic sturgeon could be in the action area year round. The maximum ambient temperature is expected to be 22°C. As explained above, even when ambient temperatures are there warmest, the surface area that Atlantic sturgeon are likely to avoid (28°C) is less than 11.25 acres. The benthic area is even smaller (less than 3 acres). Atlantic 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 Atlantic 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 shortnose 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 shortnose 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.

Given that Atlantic sturgeon are known to actively seek out cooler waters when temperatures rise to 28°C (82.4°F), any Atlantic sturgeon encountering bottom waters with temperatures above 28°C (82.4°F) area are likely to avoid it. Reactions to this elevated temperature are expected to be limited to swimming away from the plume by swimming around it. Given the extremely small percentage of the action area and of the Bay that may have temperatures elevated above 28°C and the limited spatial and temporal extent of any elevations of bottom water temperatures above 28°C, it is extremely unlikely that these minor changes in behavior will preclude 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 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 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 Atlantic sturgeon will avoid the area where temperatures are greater than tolerable. As such, it is extremely unlikely that any Atlantic 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 Atlantic 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 Atlantic 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 and Atlantic 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
NRC has concluded that thermal impacts from Pilgrim operations have not noticeably altered aquatic communities near Pilgrim, except in very small areas (i.e., less than 1 acre; NRC 2007). We have considered the potential for heated effluent to affect the abundance or distribution of prey in the action area.

Kemp's ridley and loggerhead sea turtles, as well as Atlantic 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 1°C above ambient is limited to 8.4 acres, 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 Kemp's ridley and loggerhead sea turtles and Atlantic 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). 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 to an area no larger than 0.91 acres (see above) and at the surface to an area smaller than 11.25 acres (see above). 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 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 16°C, the area at the bottom with water temperatures 1°C or more above ambient was measured at 1.08 acres (see Table 5.1-3 in ENSR 2000); the surface area above their preferred temperature would be less than 216 acres (ENSR 2000). 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 1 acre. 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 216 acres at the surface and less than 1 acre at the bottom. Mackerel tolerate temperatures up to about 20°C. During these conditions, the surface area that this species may avoid could be as large as 3,000 acres; however, because the plume is limited to depths of 4 feet from the surface, mackerel would only be displaced from surface waters, not from the entirety of this area. 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. During the time of year when right whales are foraging in Cape Cod Bay (January – May), ambient water temperatures are typically 0-10°C. Copepod distribution is not likely to be affected at temperatures below 21°C (see citations referenced above). At ambient water temperatures of 11.5°C and below, the area which would experience an increase in water temperature more than 11°C above ambient is limited to less than 0.5 acres (see table 5.1-1 in ENSR 2000); the area at the bottom which would experience temperatures this high is less than 0.13 acres. Given the small size of the area where the distribution of copepods would be affected (0.5 acres; less than 0.0002% of the surface area of Cape Cod Bay) and that copepods are likely to avoid the area rather than be injured or killed, any effect to foraging right whales is extremely unlikely.

Effect on Oceanographic Features

We have considered the potential for the thermal plume to affect oceanographic features that serve to aggregate copepods. As discussed by Pace and Merrick (2008), the prominent source of copepods that become aggregated in Cape Cod Bay is Wilkinson and Jordan Basin; circulation patterns within Cape Cod Bay entrain these copepods produced elsewhere and serve to aggregate the copepods in densities sufficient for right whale foraging. These source areas are at least 100 miles away and "upstream" from the waters where the thermal plume is detectable so it is extremely unlikely that these sources of copepods are affected at all by operations of Pilgrim.

Several factors are thought to concentrate copepods in Cape Cod Bay. These include currents and circulation patterns, bathymetric features (basins, banks, and channels), oceanic fronts, density gradients, and temperature regimes (Wishner *et al.*. 1988, Mayo and Marx 1990, Murison and Gaskin 1989, Baumgartner *et al.*. 2003a, Jiang, et al 2007, Pace and Merrick 2008). The major oceanographic features include the Maine Coastal Current (MCC), Georges Bank anti-cyclonic frontal circulation system, the basin-scale cyclonic gyres (Jordan, Georges and Wilkinson), the deep inflow through the NEC, the shallow outflow via the Great South Channel and the shelf-slope front (SSF) (Gangopadhyay *et al.*. 2003, Pace and Merrick 2008). It is also thought that some variability in the availability of copepods is linked to water temperature changes associated with the North Atlantic Oscillation (Greene at al. 2004). It is thought that these features combine to result in conditions that affect the distribution of copepods throughout the Gulf of Maine, including Cape Cod Bay. We have considered whether the thermal plume from Pilgrim could affect any of these conditions in a way that would affect copepods and therefore, foraging right whales. However, because these conditions and patterns are regional to global scale, and temperature increases from Pilgrim are not detectable at distances more than 1.4 miles from the outfall, it is extremely unlikely that any of these conditions would be affected by the thermal plume. Therefore, it is extremely unlikely that the factors that serve to aggregate copepods in Cape Cod Bay would be affected by continuing operations of Pilgrim.

Other Pollutants Discharged from the Facility

Pollutants discharged from Pilgrim are regulated under the facility's NPDES permit (MA0003557; EPA 1991 and EPA 1994). 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 Pilgrim are at levels at or below EPA's aquatic life criteria.

During spring, summer, and fall, the circulating water system is chlorinated for up to two hours per day, one hour each pump, to control nuisance biological growth. Total residual chlorine cannot exceed 0.10 parts per million (ppm) in the cooling water discharge (outfall 001). Continuous chlorination of the service water system can be used to control nuisance biological organisms with a maximum daily concentration of 1.0 ppm and an average monthly concentration of 0.5 ppm in the service water discharge (outfall 010). During chlorination, the screens are operated, and sodium thiosulfate is added to the wash water to neutralize the chlorine. Sodium thiosulfate is considered nontoxic. Entergy has confirmed that no other biocides are used at Pilgrim.

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 Pilgrim facility, the relevant water quality criteria are the Massachusetts water quality criteria, which must be certified by EPA every three years. This certification process is designed to ensure that the MA 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 that 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) Entergy 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.

As described in the REMP, radioactivity released from the liquid effluent system to the environment is limited, controlled, and monitored by a variety of systems and procedures which include: reactor water cleanup system; liquid radwaste treatment system; sampling and analysis of the liquid radwaste tanks; and, liquid waste effluent discharge header radioactivity monitor. Effluent is tested for radioactivity before being released and is only released if the radioactivity levels are below the federal release limits. Thus, releases would only occur to Cape Cod Bay after it is determined that the amount of radioactivity in the wastewater is diminished to acceptable levels that meet NRC criteria. The NPDES permit issued by EPA requires that all discharges of radioactive materials be in compliance with NRC criteria.

We reviewed the Radiological Effluent Release Reports for 2008, 2009 and 2010 (Entergy 2009b, 2010b and 2011b). There were no releases of liquid effluents containing radioactivity in 2008, four in 2009 and six in 2010. For the six 2010 discharges, the mean concentration of fission/activation products was 0.0000000000600 gCi/mL; the mean concentration of tritium in these discharges was 0.00000000404 pCi/mL (Entergy 2011b).

As reported in the most recent REMPs, during 2008, 2009 and 2010, samples (except charcoal cartridges) collected as part of the REMP at Pilgrim continued to contain detectable amounts of naturally-occurring and man-made radioactive materials. No samples indicated any detectable radioactivity attributable to Pilgrim Station operations. This suggests that despite the discharge of radioactive effluent from Pilgrim during these years, this low level of radioactivity is not detectable in the environment above background levels. These results were consistent in surface water samples, sediments (including collections in the discharge canal), Irish moss, blue mussels, soft shell clams, quahogs, lobsters and four groups of fish (bottom oriented, near bottom, anadromous and coastal migratory). Naturally-occurring potassium-40, radium-226, and actinium/thorium-228 were detected in several of the surface water samples, especially those composed primarily of seawater. Eleven samples of fish were collected during 2010. The only radionuclides detected in any of the samples were naturally-occurring potassium-40 and radium-226. No radioactivity attributable to Pilgrim was detected in any of the samples collected during 2008-2010, and results of any detectable naturally occurring radioactivity were similar to those observed in the preoperational monitoring program.

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 Pilgrim, 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 Pilgrim. As such, radiological impacts to these species are extremely unlikely. Thus, NMFS considers 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. The period considered for extended operations of Pilgrim is limited to 20 years (i.e., through June 8, 2032). We considered climate change impacts in the action area over the next 20 years to provide context within which the effects of the action will occur from present to June 8, 2032. 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 Cape Cod

Bay 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 0.6-0.8°C between now and 2032 and a 0.003-0.004 unit drop in pH per year, with a drop of 0.06-0.08 units between now and 2032. Given this small increase, it is not likely that over the proposed 20-year 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); these 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 "a number of these postulated accidents are not expected to occur during the life of the plant, but are evaluated to establish the design basis for the preventive and mitigative safety systems of the facility" (NRC 2007). 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 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 Pilgrim 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 Pilgrim that would affect the marine environment, and subsequently affect listed species and critical habitat, 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.

Dredging at Pilgrim

Indirect effects are those that are caused by the proposed action and are later in time, but are still reasonably certain to occur. They include the effects on listed species or critical habitat of future activities that are induced by the action subject to consultation. Interrelated actions are those that are part of a larger action and depend upon the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration (50 CFR 402.02; see also 1998 FWS-NMFS Joint Consultation Handbook, pp. 4-26 to 4-28). Entergy occasionally carries out dredging in the discharge canal and in the intake embayment (J. Schiffer, Entergy, pers. Communication[8]). Dredging is not required as a condition of Pilgrim's existing operating license and is not considered as part of the proposed license. Entergy indicated that dredging occurs approximately every 12 years. Dredging last occurred in 2011 and in 1999. Because dredging occurs approximately every 12 years, it is likely that dredging would occur once during the 20 year extended operating period.

We have considered whether the effects of this dredging fit the definitions of indirect effects and the definitions of interrelated or interdependent actions. For the reasons explained below, we have determined that while the future dredging can be considered an interrelated or interdependent action, the effects of the future dredging are so uncertain that they do not meet the definition of indirect effects and cannot be meaningfully considered in this consultation. The dredging meets the definition of an interdependent action because it has no independent utility apart from the continued operation of Pilgrim (i.e., but for the continued operation of Pilgrim there would be no need to remove sediment from these areas). It also meets the definition of an interrelated action because while the dredging is not part of the action proposed by NRC (i.e., continued operation of Pilgrim), it does rely solely on NRC's proposed action for its justification. Again, the dredging would not occur "but for" the issuance of a license by NRC. The effects of dredging, however, do not meet the definition of indirect effects. While the effects of dredging will be "caused" by the continued operation of Pilgrim and the need to maintain the intake and discharge areas to support such operation, and some type and amount of dredging will occur later in time according to Entergy, we lack a reasonable certainty regarding the effects that will occur in the future for several reasons. First, no specific plans for future dredging are available; also, no permits or approvals, which are required from the U.S. Army Corps of Engineers, have been obtained. This sheds uncertainty on both the future dredging project itself and its potential effects. Second, while we have a general idea of the location where dredging will occur and know, generally, the types of dredges that could be used to complete the dredging, we have no information on the volume of material to be removed, the timing of the dredging (i.e., the season), the duration of dredging or the actual type of dredge to be used. Different types of dredges can pose different risks to listed species and habitat. Information on all of these factors is necessary to consider effects of the dredging on listed species. Therefore, while a dredging project itself meets the definitions of an interrelated and interdependent activity, the effects of

[8] Phone conservation between J. Schiffer, Entergy, and Mark Murray-Brown, NMFS on May 7, 2012.

the dredging are not reasonably certain at this time for us to consider them in this consultation. However, any proposals for future dredging will need a permit from the U.S. Army Corps of Engineers, which would trigger the need for a subsequent ESA Section 7 consultation.

Effects to Right Whale Critical Habitat

We have considered whether the continued operation of Pilgrim would have any direct or indirect effects to right whale critical habitat. Right whales use the waters of Cape Cod Bay for foraging. Within critical habitat, the thermal plume is no longer detectable and any pollutants discharged from Pilgrim, including chlorine, are fully mixed and would no longer be detectable from background levels. As such, there would be no direct effects to critical habitat. We do expect that the continued operation of Pilgrim would result in a reduction in copepods compared to the levels that would be present if no copepods were entrained at Pilgrim. However, as explained above, because we expect the loss to be extremely small and undetectable from natural variability, the effect of this loss on foraging right whales will be insignificant. We do not expect mortality of copepods from exposure to the thermal plume as we expect copepods to avoid areas above their thermal tolerance (see Lenz *et al.*. 2005 for a discussion of the escape response of copepods); we expect these effects to distribution to be minor and be limited to an area outside of critical habitat. Copepods in Cape Cod Bay originate from Jordan, Wilkinson and George's Basin. The influence of Pilgrim does not extend to these areas and we do not expect any effects to the generation of copepods in these areas that could be attributable to the continued operation of Pilgrim. The operation of Pilgrim will also not affect any of the physical or oceanographic conditions that serve to aggregate copepods in Cape Cod Bay. For these reasons, there will be no indirect effects to critical habitat. Therefore, we have determined that the continued operation of Pilgrim will have no effect on right whale critical habitat.

CONCLUSION

As discussed on our March 22, 2012 call, we do not agree with your determination that the proposed renewal will have no effect on listed species. The agencies agreed, however, to engage in informal consultation to determine whether formal consultation was necessary or if consultation could be concluded with a "not likely to adversely affect" finding. As explained above, based on information from NRC, Entergy, and other sources, all effects to listed species will be insignificant or discountable. Therefore, the continued operation of Pilgrim under the terms of a renewed operating license is not likely to adversely affect any listed species under NMFS jurisdiction. We have determined that the continued operation of Pilgrim will have no effect on right whale critical habitat.

Reinitiation of consultation is required and shall be requested by the Federal agency or by the Service, 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 Pilgrim, including in the discharge canal, 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 Pilgrim facility. While this information was not necessary to complete this consultation, we request that you consider adding conditions to any new license for Pilgrim to require: (1) monitoring and reporting zooplankton entrainment, including copepods (particularly, *Calanus finmarchus, Pseudocalanus* spp. and *Centropages* spp); (2) monitoring zooplankton at nearfield and farfield locations to serve as a check on your determination that effects of Pilgrim on zooplankton are small and localized; (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 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 and occasionally entrained at Pilgrim (NRC 2007, Normandeau 2011b and ENSR 2000). 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. We also request that you work with Entergy to investigate why early life stages (larvae) of alewife are present near the intakes (as evidenced by entrainment (NRC 2007)). Alewife normally spawn in freshwater and presence of early life stages in marine waters, such as the Pilgrim intake, is unexpected and warrants further investigation to determine if the operations of Pilgrim contribute to this unusual behavior or if it is due to unrelated factors. 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) 281-9328.

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 Pilgrim 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,

George W. Darey

for Daniel S. Morris
Acting Regional Administrator

Cc: Chiarella, F/NER4
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File code: Sec. 7 NRC Pilgrim Power Station
PCTS: I/NER/2006/07083

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
ENTERGY NUCLEAR OPERATIONS, INC.	)	Docket No. 50-293-LR
	)	
(Pilgrim Nuclear Power Station)	)	ASLBP No. 12-917-05-LR
	)	

CERTIFICATE OF SERVICE

I hereby certify that copies of the foregoing Letter to the Atomic Safety and Licensing Board regarding the Attached ESA Informal Consultation from the NMFS, dated May 22, 2012, in the above-captioned proceeding have been served on the following by the Electronic Information Exchange, this 22nd day of May, 2012.

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