October 19, 2006

Mr. Pace Wilber
Atlantic Branch Supervisor, Fishery Biologist
National Marine Fisheries Service
Charleston Field Office (LR/SER 45)
217 Fort Johnson Road
Charleston, SC 29412-9110

SUBJECT: ESSENTIAL FISH HABITAT ASSESSMENT FOR LICENSE RENEWAL OF BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2

Dear Mr. Wilber:

The U.S. Nuclear Regulatory Commission (NRC) staff has prepared the enclosed final essential fish habitat (EFH) assessment regarding license renewal of the Brunswick Steam Electric Plant, Units 1 and 2 (BSEP), operating licenses for a period of an additional 20 years. The EFH assessment was prepared in accordance with the Magnuson-Stevens Fishery Conservation and Management Act (Public Law 94-265) and the implementing regulations found in Title 50, Part 600, Subparts J and K, of the *Code of Federal Regulations*.

The Federal action of license renewal is not a major construction activity. BSEP is located in Brunswick County in southeastern North Carolina, near the mouth of the Cape Fear River. The NRC staff's assessment considers the impacts of BSEP operation on species managed by the South and Mid-Atlantic Fishery Management Councils and on their EFHs. Impacts on each species, EFH, and habitat area of particular concern, where designated, were evaluated by life stage.

The NRC staff met with representatives from Progress Energy Carolinas, Inc. (the applicant), the National Marine Fisheries Service - Southeast Regional Office (NMFS), and the State, at BSEP to tour the facility and discuss the EFH consultation process in December 2005. In preparing our assessment and reaching our conclusion, the NRC staff relied on information provided by the applicant, literature research, interviews conducted by NRC staff with experts, and information from NMFS's Southeast Regional Office. The NRC staff determined that the continued operation of BSEP for an additional 20 years would have a minimal adverse effect on species managed by the South and Mid-Atlantic Fishery Management Councils and their EFHs. We request that NMFS review the enclosed EFH assessment. We look forward to receiving your determination.

If you have any questions regarding this assessment or the staff's request, please contact Alicia Williamson, Environmental Project Manager, at 301-415-1878 or by e-mail at arw1@nrc.gov.

Sincerely,

/RA/

Rani Franovich, Chief
Environmental Branch B
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket Nos. 50-324 and 50-325

Enclosure:
Essential Fish Habitat Assessment

cc w/encl: See next page

If you have any questions regarding this assessment or the staff's request, please contact Alicia Williamson, Environmental Project Manager, at 301-415-1878 or by e-mail at arw1@nrc.gov.

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ADAMS Accession Number: **ML062770227**

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Letter to P. Wilber from R. Franovich, dated October 19, 2006

SUBJECT: ESSENTIAL FISH HABITAT ASSESSMENT FOR LICENSE RENEWAL OF BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2

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Essential Fish Habitat Assessment

Brunswick Steam Electric Plant, Units 1 and 2

License Renewal Review

Docket Numbers
50-325
50-324

U.S. Nuclear Regulatory Commission
Rockville, Maryland

October 2006

Assessment of the Potential Effects on Essential Fish Habitat from the License Renewal for the Brunswick Steam Electric Plant, Units 1 and 2

1.0 Introduction

The U.S. Nuclear Regulatory Commission (NRC) licenses the operation of domestic nuclear power plants in accordance with the Atomic Energy Act of 1954, as amended, and NRC's implementing regulations. The Carolina Power & Light Company (CP&L), now doing business as Progress Energy Carolinas, Inc., operates Brunswick Steam Electric Plant, Units 1 and 2 (BSEP) in southeastern North Carolina under Operating Licenses (OLs) DPR-62 and DPR-71, respectively. The OL for Unit 1 will expire September 8, 2016, and the Unit 2 license will expire December 27, 2014. CP&L applied to renew the OLs for BSEP, and the proposed action evaluated in this assessment is the renewal of the OLs.

The consultation requirements of Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) provide that Federal agencies consult with the Secretary of Commerce on all actions, or proposed actions, authorized, funded, or undertaken by the agency, that may adversely affect Essential Fish Habitat (EFH). EFH is defined as those waters and substrates necessary to fish for spawning, breeding, or growth to maturity.

BSEP is located in Brunswick County in southeastern North Carolina, near the mouth of the Cape Fear River. The Cape Fear Estuary serves as the source of cooling water for BSEP, and discharge water is piped into the Atlantic Ocean. Pursuant to the Endangered Species Act, a letter dated August 9, 2006, provided the National Marine Fisheries Service (NMFS) with a biological assessment regarding license renewal of BSEP, Units 1 and 2 (NRC 2005). By letter dated September 19, 2005, NMFS responded by stating that a need for reinitiation did not exist and that the January 20, 2000, biological opinion would remain in full force and effect for the continued operation of BSEP. In April 2006, the NRC staff issued Supplement 25 to NUREG-1437, the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, regarding BSEP (NRC 2006).

On November 30, 2005, NRC staff met with staff from NMFS and North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries, at the Brunswick site to view the intake and discharge systems at the plant and to discuss the EFH consultation process. Licensee personnel presented and discussed the preoperational monitoring studies and the results that were used as a baseline to assess changes resulting from plant operations. Discussions included a description of the original BSEP intake design and subsequent modifications as well as a synopsis of the studies conducted as part of the 316(b) demonstration as required by the Clean Water Act. Because Federally managed species and their EFHs are present in the vicinity of BSEP and because BSEP operation could affect such species and EFHs, it was agreed that an EFH Assessment would be prepared.

2.0 Proposed Federal Action

The proposed Federal action is renewal of the OLs for BSEP Units 1 and 2. The new BSEP OLs would expire in 2036 and 2034 for Units 1 and 2, respectively. No major refurbishment or replacement of important systems, structures, or components is expected during the 20-year BSEP license renewal term. In addition, no construction activities are expected to be associated with license renewal. The reactors and support facilities, including the cooling system, are expected to continue to operate and be maintained until the renewed licenses expire in the mid 2030s. Continued maintenance activities on the transmission line rights-of-way that are used to connect BSEP to the electric power grid also would be required if the proposed action is implemented.

Pursuant to 10 CFR 54.23 and 51.53(c), CP&L submitted an Environmental Report (CP&L 2004) that analyzed the environmental impacts associated with the proposed license renewal action, considered alternatives to the proposed action, and evaluated mitigation measures for reducing adverse environmental effects. The NRC is using this report, independent analysis, and other available information as the basis of this EFH Assessment.

3.0 Environmental Setting

BSEP is located in Brunswick County, in southeastern North Carolina, near the mouth of the Cape Fear River. The area within a 6-mi radius of the plant includes the town of Southport, the community of Boiling Spring Lakes, and the resort communities of Caswell Beach, Oak Island, and Bald Head Island. Wilmington, North Carolina, lies approximately 15 mi north of the BSEP site, and Myrtle Beach, South Carolina, lies approximately 50 mi to the southwest along the coast. The Military Ocean Terminal Sunny Point is situated immediately north of the BSEP site. Figure 1 shows the BSEP site location and features in the surrounding area.

Cooling water for BSEP is drawn from the Cape Fear River by way of a 3-mi-long intake canal that passes from the river to BSEP. After passing through the plant's condensers, the heated water travels through a 6-mi-long discharge canal to Caswell Beach where it is pumped 610 m offshore through two large submerged pipes into the Atlantic Ocean (Figure 1).

BSEP is surrounded by a diverse and complex aquatic ecosystem. Aquatic habitat types surrounding the plant include salt marshes, the river channel and estuary, and offshore regions (CP&L 1980). The plant is in an estuarine environment situated approximately 5.7 mi upstream of the mouth of the Cape Fear River (CP&L 1985). The Cape Fear River watershed is the largest watershed in North Carolina and drains into the Cape Fear Estuary. Estuaries are partially enclosed coastal areas where freshwater and saltwater mix. These areas are under tidal influence, but they are protected from the full force of the ocean by barrier islands, salt marshes, or other land forms. The species found in estuaries are specially adapted for life in this transitional area. Estuaries are considered to be among the most productive areas on earth (EPA 2005).

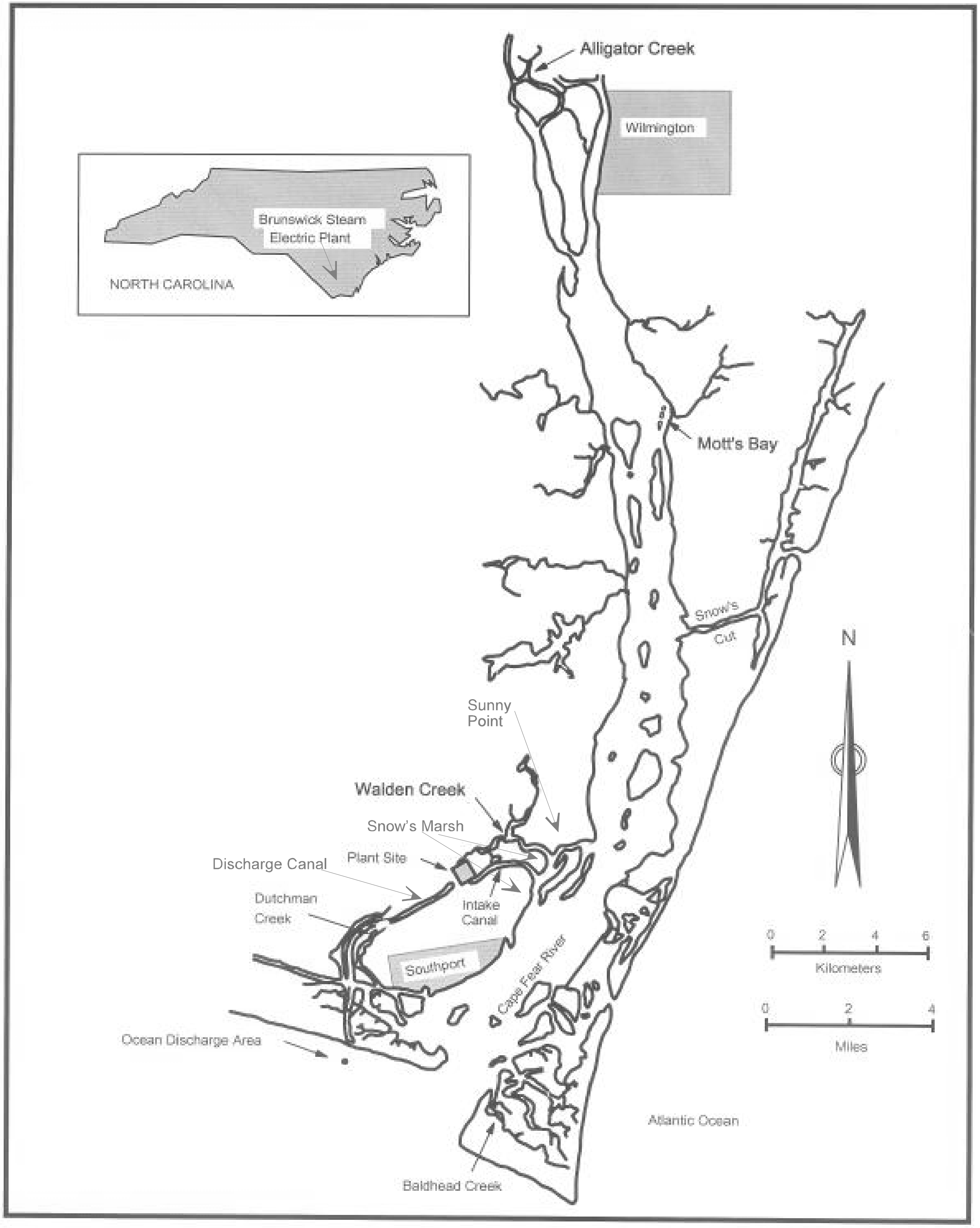

Figure 1. Brunswick Site and Surrounding Area

The region surrounding the BSEP intake canal entrance, just downstream of Sunny Point, is in an area that experiences a large tidal exchange (CP&L 1985). Salinity is influenced primarily by tidal conditions and the rate of freshwater inflow. A salinity gradient exists where freshwater from the Cape Fear River mixes with saltwater from the Atlantic Ocean. From Sunny Point upstream to Wilmington, the water is often two-layered, with the freshwater moving downstream over the denser seawater (CP&L 1980). Downstream from Sunny Point, the water is more uniformly mixed because of complex water circulation patterns, vigorous tidal action, and high exchange rates with the ocean. This portion of the estuary is shallow and irregular in shape, with many islands and channels that enhance mixing (CP&L 1980, 1985). Because the freshwater inflow from the Cape Fear River and its tributaries is highly variable, salinities at the intake may range from nearly 0 to 32 parts per thousand (ppt) (AEC 1974). During periods of average freshwater inflow, salinities near Sunny Point are generally in the range of 8 to 15 ppt (CP&L 1980). At the mouth of the estuary, the annual salinity range is 18-37 ppt with an annual average near 32 ppt (CORMP 2005). Minimum salinities are generally recorded in winter, and maximum salinities are generally recorded in late summer (CP&L 1985).

Water temperatures in the estuary are influenced largely by changes in season, with the warmest temperatures (as high as 39.4 °C) observed during late summer (CP&L 1985). Annual low water temperatures, measured at three stations in the estuary, range between 8 and 9 °C. Annual mean temperatures range from 19.2 to 19.5 °C at these three stations (Mallin et al. 2003). The Cape Fear River estuary is relatively shallow, with the vast majority of the estuary being less than 3 m deep, and some areas being up to 5.2 m deep (NOAA 1997). A navigation channel is dredged in the western portion of the estuary, and this channel may be up to 12.2 m deep. The substrate at the mouth of the estuary is composed of calcareous gravel, sand, and silt (McLeod 2001).

The BSEP site and the surrounding area include several types of wetlands: freshwater, brackish, and salt marshes; swamps; Carolina bays; pocosins; and coastal dunes. Most notably, the intake canal cuts through Snow's Marsh; like other salt marshes in the vicinity, Snow's Marsh is dominated by cordgrass (*Spartina alterniflora*) and needlerush (*Juncus romerianus*) (CP&L 2004). The tidally influenced salt marshes provide shelter and food for larvae and juveniles of many fish and shellfish species in the Cape Fear Estuary. Downstream of the BSEP intake, Zeke's Island Estuarine Research Reserve is located just south of Southport in New Hanover and Brunswick Counties (NCNERR 2006).

North Carolina has a nursery system designed to protect salt marshes and estuaries that serve as important habitats for juvenile fish and shellfish. The State has designated 80,144 acres as Primary Nursery Areas, 35,502 acres as Secondary Nursery Areas, and 31,362 acres as Special Secondary Nursery Areas (NCDMF 2006). Primary Nursery Areas are estuarine areas where initial post-larval development occurs and are usually in the low-salinity upper portions of creeks and bays near marshes and other wetlands. Secondary Nursery Areas are estuarine areas where later juvenile development occurs and are usually in the brackish lower portions of creeks and bays. The Cape Fear Estuary contains State-designated nursery areas, which are important habitats for estuarine-dependent fish and shellfish larvae and juveniles.

Some estuarine-dependent species, such as anchovy (*Anchoa* spp.) and gobies (*Gobionellus* spp., *Gobiosoma* spp.) spawn in the estuary, while others, such as Atlantic menhaden (*Brevoortia tyrannus*), spot (*Leiostomus xanthurus*), croaker (*Micropogonias undulatus*), and pinfish (*Lagodon rhomboides*) spawn in the ocean (PEC 2003). Salinity and temperature influence the spatial and seasonal distribution of these species (CP&L 1985). The tidal exchange also contributes to the transport and/or retention of larvae and other organisms throughout the estuary (CP&L 1980).

Many species that inhabit waters in the vicinity of the BSEP have commercial or recreational value. Brown shrimp (*Farfantepenaeus aztecus*), pink shrimp (*F. duorarum*), and white shrimp (*Litopenaeus seiferus*) inhabit salt marshes, including Snow's Marsh, which borders the intake canal (CP&L 1980). The shrimp spawn in offshore waters, and the post-larvae are recruited into the estuary where they find food and protection. As the shrimp mature, they migrate to deeper waters where commercial fishermen harvest them (AEC 1974). Croaker, an important food fish and sport fish, is another inhabitant of the salt marsh, including Snow's Marsh (AEC 1974). Croaker spawn in the ocean during fall and winter. The young spend their first year in the low-salinity regions of the estuary and then move to the ocean. Examples of other species found in salt marshes near BSEP include blackcheek tonguefish (*Symphurus plagiusa*), striped anchovy *(Anchoa hepsetus*), Atlantic menhaden, and pinfish (AEC 1974).

In the river channel and estuary, developing larvae of brown, pink, and white shrimp, as well as blue crab (*Callinectes* spp.) can be found (AEC 1974). The estuary supports larval fish year-round, although the species composition, including anchovy, croaker, gobies, spot, blackcheek tonguefish, Atlantic menhaden, and striped mullet (*Mugil cephalus*), varies by season. Important adult fish using the estuary include gray sea trout (*Cynoscion regalis*), spot, croaker, bay anchovy (*Anchoa mitchilli*), summer flounder (*Paralichthys dentatus*), windowpane flounder (*Scophthalmus aquosus)*, American shad (*Alosa sapidissima*), alewife (*Alosa pseudoharengus*), and blue backed herring (*Alosa aestivalis*) (AEC 1974).

The region surrounding the BSEP discharge is a saline environment (> 30 ppt) off the southern shore of Oak Island at Caswell Beach. Offshore water temperatures near Oak Island range between 10 and 29 °C, with an annual average around 18 °C (CORMP 2005). The substrate is bare sand with some mud, and there is little structure in the vicinity. The nearest live hard bottom is a limestone outcrop in the shipping channel approximately four to five mi southeast of the discharge point, and an artificial reef is located about three mi southwest of the discharge. There is no attached submerged aquatic vegetation (SAV) near the BSEP discharge (NRC 2006). The depth is about 3 m at the discharge point, and the bottom is a gradually sloping continental shelf. The region experiences strong westerly tidal and southerly longshore currents (NRC 2006).

In this offshore region near Oak Island, larvae of shrimp, anchovies, gobies, spot, croaker, gray seatrout, pinfish, and Atlantic menhaden have been recorded (AEC 1974). Adults with commercial value captured in this area include brown shrimp, pink shrimp, white shrimp, blue crab, anchovy, spot, king fish (*Mentaicirrhus americanus*), croaker, thread herring (*Opistonema oglinum*), bluefish (*Pomatomus saltatrix*), drum (*Stellifer lanceolatus*), and blackcheek tonguefish. Benthic organisms found in the mud and sand of this offshore area include snails, brittle star (*Ophiophragumus* spp.), and polychaete worms (AEC 1974).

4.0 The Plant and Cooling Water Systems

This section describes the structures and operations of BSEP.

4.1 Reactor Systems

BSEP uses boiling water reactors and steam-driven turbine generators manufactured by General Electric. As originally built and operated, each BSEP unit had a design rating of 2436 megawatts-thermal (MW(t)). Since 1996, the NRC has approved two power uprates. Each unit is now licensed to operate at 2923 MW(t), 20 percent over the original licensed maximum power level.

Each reactor's primary containment is a pressure-suppression system consisting of a drywell, a pressure-suppression chamber storing a large volume of water, a connecting vent system between the drywell and the suppression pool, a vacuum relief system, isolation valves, containment cooling systems, and other service equipment.

4.2 Cooling Water System

Cooling water for BSEP is obtained from the lower Cape Fear River (the Cape Fear Estuary) and discharged to the Atlantic Ocean at about latitude 33° 53' N. The daily maximum intake by BSEP is limited to 2210 cubic feet per second (cfs) during April through November and to 1844 cfs from December to March (NRC 2006). Water passes from the lower Cape Fear Estuary through a diversion structure that has trash racks and 3/8-in.-mesh screens to prevent biota from entering the intake canal. The water in the 3-mi-long intake canal flows via gravity from the diversion structure at the Cape Fear River to the plant. At the plant, cooling water is drawn through a combination of eight bays (four for each unit). Each bay has a trash rack, traveling screens, and an intake pump. For each unit, two bays have fine-mesh (1-mm [.04-in.]) screens installed over coarse-mesh (3/8-in.) screens, and the other two bays have half fine-mesh screens over coarse-mesh screens and half coarse-mesh screens only. Typically, each unit operates utilizing two of the fine-mesh bays and one of the half fine-mesh/half coarse-mesh bays. Organisms impinged on the traveling screens are washed into a screen-covered flume that leads to a holding basin before being released to Walden Creek, which is part of the Cape Fear River watershed.

Chlorine is injected into the circulating water intake system to prevent biofouling. According to the plant's National Pollutant Discharge Elimination System (NPDES) permit, no free residual chlorine may be discharged into the ocean. BSEP is expected to continue operating within their NPDES permit limits; therefore, no discharge of chlorine or other biocides is expected to occur.

As a result of passage through the condensers, the cooling water temperature rises about 11 °C. After passing through the plant, the heated discharge water is released into a 6-mi-long discharge canal that flows by gravity out to Caswell Beach. Depending on meteorological conditions, evaporative loss from the discharge canal is estimated to be between 5 and 10 cfs. The discharge canal is separated from the Intracoastal Waterway as the discharge water flows through a tunnel beneath the Intracoastal Waterway. At Caswell Beach the discharge water is pumped 610 m offshore into the Atlantic Ocean, where it is discharged from two side-by-side

13-ft-diameter, open-ended, concrete pipes partially buried in the bare sandy bottom in about 3 m of water.

The NPDES permit limits heated water discharge by prescribing two mixing zones to minimize thermal impacts to aquatic biota off Caswell Beach. The primary mixing zone, which is 120 ac, can receive heated discharge no greater than 3.89 °C above ambient water temperature (NRC 2006). A second, 2000-ac mixing zone can receive water no more than 2.2 °C above ambient temperature during June through August and no more than 0.8 °C above ambient temperature during September through May. Water temperature outside the 2000-ac mixing zone cannot ever exceed 32 °C. Semiannual monitoring is performed to ensure that NPDES mixing zone criteria are met. However, unless both units are operating at full power, the thermal plume is typically detectable only in a much smaller area–only a few acres. Within this small area, water temperatures have been measured at 2.78 °C greater than ambient water temperature. Environmental factors, such as wind, wave action, tides, and natural currents, mix the water and quickly dissipate the heat.

5.0 Potential Effects of Plant Operation on Biota and Habitat

BSEP operation has potential to impact marine and estuarine biota and their habitats. Water removed from the Cape Fear Estuary consists of the estuarine water column and contains organisms that may be impinged on plant intake structures or entrained through the plant in circulating cooling water that receives heat and chlorine. The marine water column off Caswell Beach would experience increased temperatures in a localized area, and organisms in the open Atlantic Ocean about 610 m offshore could be exposed to elevated water temperatures from the thermal discharge plume.

5.1 Impingement

Impingement occurs when organisms are trapped against the screens on the diversion structure or intake bays due to the current of water entering the cooling system. Impinged organisms may experience starvation, exhaustion, asphyxiation, and descaling. Large organisms can be impinged on the trash racks and screens at the diversion structure at the intake canal's entrance. Also, smaller organisms are impinged on the fine-mesh traveling screens at the plant's intake. Many organisms that are impinged at the plant's intake survive and are returned in the fish-return flume to the estuary via Walden Creek.

Based on 2003 data, the most common species in the larval impingement study was spot, which accounted for almost 23 percent of the total larval impingement (PEC 2003). Since 1984, the ten most abundant taxa in larval impingement sampling have remained in the top ten. Those include penaeid shrimp, *Anchoa* spp., croaker, pinfish, weakfish (*Cynoscion regalis*), portunid megalops (Family Portunidae), Atlantic menhaden, *Gobiosoma* spp., and *Gobionellus* spp.

Also, survival studies were conducted in 2003 for impinged larvae. Over half of the sampled taxa had high survival rates, averaging about 87 percent (PEC 2003). *Anchoa* spp. had the lowest larval impingement at only 0.7 percent survival. Penaeid shrimp and blue crab had the highest survival rates with over 90 percent of impinged larvae returned to the estuary alive.

In the juvenile and adult impingement study conducted in 2003, bay anchovy and shrimp were the most common taxa, at 67.4 percent and 19.1 percent, respectively, of the sampling total, whereas Atlantic menhaden, spot, and croaker were the most abundant in the 1983 juvenile and adult impingement sampling (PEC 2003).

Survival studies were also conducted for impinged juveniles and adults in 2003. Over half of the sampled taxa had high impingement survival rates for juveniles and adults; their average was about 85 percent survival (PEC 2003). As with larval impingement survival, the bay anchovy had the lowest survival rate (4.9 percent) for impinged juveniles and adults. Excluding the bay anchovy data, 68.9 percent of all sampled juveniles and adults survived impingement. Penaeid shrimp, blue crab, and striped mullet exhibited survival rates of over 90 percent for impinged juveniles and adults that were returned to the estuary alive.

5.3 Entrainment

Entrainment is the movement of objects or organisms through the cooling water intake structure and into the plant's cooling system. Typically, entrained organisms are very small and, therefore, pass through the traveling screens at the intake bays. Entrained organisms are drawn through the traveling screens and pass into the plant with the cooling water. Gaseous chlorine is injected into the cooling water for each unit for four hours each day. This brings the chlorine concentration up to 0.1 parts per million for 15 to 20 minutes, but all residual chlorine is removed before the water is discharged. Next the cooling water passes through the impellers of the intake pumps and then is heated by more than 11 °C for a short period of time until it exits the plant. While in the plant, entrained organisms are subjected to pressure changes, mechanical damage, toxic exposure, and thermal stress associated with pump operation and heat removal. Although the heated discharge begins to cool immediately, entrained organisms are subjected to elevated temperatures for up to a few hours as they pass through the discharge canal and pipes and are released in the thermal plume to the open ocean about 610 m off Caswell Beach.

From the 2003 study results, spot was also the most abundant species entrained, accounting for almost a third of all entrained organisms (PEC 2003). The top ten taxa entrained make up 93 percent of the total; the other most abundant taxa were *Gobiosoma* spp., *Anchoa* spp., croaker, pinfish, silversides, shrimp, Atlantic menhaden, and *Gobionellus* spp. Based on entrainment rates with only coarse-mesh screens, the addition of fine-mesh traveling screens reduced entrainment at BSEP by about 25 percent, with shrimp and crab larvae experiencing the greatest reduction (PEC 2003).

Because of differences in acclimation temperature, condition, and life stage of individuals within a species, as well as the variability of survival rates between species, entrainment survival estimates vary widely. Entrainment survival studies have demonstrated that, for a 11 °C increase in temperature, survival rates, particularly for some life stages of hardy species, can be high (CP&L 1985). However, 100 percent mortality of entrained organisms is assumed for the purposes of this EFH Assessment.

5.3 Thermal Effects

Habitat potentially affected by operation of the BSEP discharge consists of the marine water column above the discharge pipe outlet. Heated discharge water has the potential to induce heat shock in animals, creating stress upon exposure to high temperatures. Also, if animals have acclimated to the thermal discharge, the potential exists for cold shock, which could occur if the plant has to shut down or slow down the operation of the cooling system, thus reducing thermal discharge and decreasing the water temperature in the immediate vicinity of the otherwise heated discharge. However, there have been no recorded cases of heat shock, cold shock, or fish kills in the Atlantic Ocean resulting from BSEP discharge. BSEP's thermal plume is localized and affects a small fraction of one percent of available habitat in the region. Also, fish can use avoidance behavior to swim away from the thermal plume if they cannot tolerate the slightly increased water temperature. Because BSEP operates within NPDES permit limits, the thermal plume is small, and the discharged heat dissipates quickly, it is unlikely that the thermal plume significantly impacts marine biota or habitat in the Atlantic Ocean. Nevertheless, the thermal plume would continue if the proposed action is implemented so potential effects of heated discharge water are analyzed in this assessment.

6.0 Potential Effects of the Proposed Action on Designated EFH and Federally Managed Species

BSEP is located in an area that provides EFH for species managed by both the Mid- and South Atlantic Fishery Management Councils. Also, highly migratory species managed by NMFS and their EFHs occur in the vicinity of BSEP. The NRC staff began its evaluation by considering all designated EFH that could occur in the vicinity of BSEP. The staff conducted a screening process to eliminate species and their EFHs that would not be in the scope of this assessment. Table 1 lists the resulting species and life stages for which designated EFH potentially occurs in the vicinity of BSEP. Table 1 also indicates whether Habitat Areas of Particular Concern (HAPCs) exist for each species.

Because BSEP is close to the mouth of the Cape Fear River, the habitat at the intake is considered both estuarine and marine for the purposes of this EFH Assessment while the habitat at the BSEP discharge is purely marine. The following discussions of life stages and habitat preferences for the species listed in Table 1 include evaluations of potential effects of continued BSEP operations on EFH.

Penaeid Shrimp

Penaeid shrimp species occurring in the vicinity of BSEP include brown shrimp (*Farfantepenaeus aztecus*), pink shrimp (*F. duorarum*), and white shrimp (*Litopenaeus setiferus*). Within the vicinity of BSEP, peneaid shrimp EFH exists for eggs for pink shrimp and white shrimp, and for larvae, postlarvae, juveniles, subadults, and adults for all three species (NMFS 2004).

Table 1. Species Managed by the South and Mid-Atlantic Fishery Management Councils and the National Marine Fisheries Service Potentially Occurring in the Vicinity of Brunswick Steam Electric Plant

Species	Eggs	Larvae	Juveniles	Subadults	Adults	HAPC
brown shrimp - *Farfantepenaeus aztecus*		M*	E*	E	M	√*
pink shrimp - *F. duorarum*	M	M	E	E	M	√
white shrimp - *Litopenaeus setiferus*	M	M	E	E	M	√
rock shrimp - *Sicyonia brevirostris*					M	
red drum - *Sciaenops ocellatus*	M	M	E	E	M/E	√
red snapper - *Lutjanus compechanus*		M	M[1]			√
gray snapper - *L. griseus*		M	E[1]		M/E	√
white grunt - *Haemulon plumieri*	M	M			M	√
blueline tilefish - *Caulolatilus microps*	M					√
bluefish - *Pomatomus saltatrix*	M	M	M/E		M/E	
summer flounder - *Paralichthys dentatus*		M/E	M/E		M/E	√
cobia - *Rachycentron canadum*		M/E	M/E[1]		M/E	√
king mackerel - *Scomberomorus cavalla*			M		M	√
Spanish mackerel - *S. maculatus*			M/E		M	√
spiny dogfish - *Squalus acanthias*			M/E		M/E	
scalloped hammerhead - *Sphyrna lewini*		M[2]	M			
dusky shark - *Carcharhinus obscurus*		M/E[2]	M			
sandbar shark - *Carcharhinus plumbeus*		M/E[2]	M/E		M/E	
tiger shark - *Galeocerdo cuvieri*		M/E[2]	M/E		M/E	
sand tiger shark - *Odontaspis taurus*		M[2]	M		M	
bonnethead shark - *Sphyrna tiburo*		M/E[2]	M/E		M/E	
Atlantic sharpnose shark - *Rhizoprionodon terraenovae*		M/E[2]	M/E		M/E	

* M = EFH in marine ecosystem; E = EFH in estuarine ecosystem; √ denotes presence of HAPCs near BSEP.
[1] Includes postlarval life stage for this species.
[2] EFH identified for neonates because this species does not have larvae.
Sources: NMFS 2004 and NMFS 2006a.

Pink shrimp EFH

EFH for pink shrimp eggs occurs near the bottom in marine waters at depths of 3.7-16 m. Larval EFH is the marine water column with preferred depths of less than 16 m. EFH for postlarvae, juveniles, and subadults occurs in and along marshes and submerged aquatic vegetation (SAV) in estuarine waters with sandy and shell substrates. Adult pink shrimp EFH is designated in the marine water column and requires hard sand or shell substrate with depths of less than 100m.

White shrimp EFH

White shrimp eggs have EFH near the bottom in nearshore marine waters at depths of 6.1-24.4 m. Larval EFH for white shrimp is the marine water column with preferred depths of less than 24.4 m. EFH for postlarvae, juveniles, and subadults occurs in and along marshes and SAV in estuarine waters with muddy substrate. Adult white shrimp EFH is designated in the marine water column and requires a soft, muddy substrate at depths of less than 27 m.

Brown shrimp EFH

Larval EFH for brown shrimp is the marine water column with preferred depths of less than 110 m. EFH for postlarvae, juveniles, and subadults occurs in and along marshes and SAV in estuarine waters with muddy substrate. Adult brown shrimp EFH is designated in the marine water column and requires silty or muddy sand at depths of less than 110 m.

Also, HAPCs for penaeid shrimp species have been identified to include State-designated nursery and overwintering habitats, tidal inlets, and estuarine shoreline habitats, such as those along tidal creeks, salt marshes, and barrier islands, which include the Cape Fear Estuary.

Brown shrimp prefer soft muddy substrate, which could be near the BSEP intake. While in inshore areas, such as near BSEP intake, white shrimp prefer substrates with high organic content. Pink shrimp, however, prefer harder sandy and calcareous substrate so they are less likely to occur near BSEP. Brown and pink shrimp typically bury in the substrate during the day while pink shrimp do not demonstrate burying activity as regularly.

Penaeid shrimp prefer water temperatures of 22-29 °C for spawning (SAFMC 1998). Brown shrimp probably spawn between late fall and late winter in waters greater than 13.7 m deep. Pink and white shrimp spawn in late spring to early summer in the Carolinas and prefer depths of 3.7-15.8 m during spawning season.

Environmental factors affect penaeid shrimp growth rates. For brown shrimp, higher growth rates are exhibited with salinity above 10 ppt and temperature above 25 °C (SAFMC 1998). Data show that pink shrimp in North Carolina have highest growth rates in summer months. White shrimp growth rates are inhibited by high salinity and high density.

Larval shrimp are planktonic and eat mostly zooplankton, algae, and detritus. Juvenile, subadult, and adult penaeid shrimp are opportunistic, benthic omnivores. They are typically nocturnal feeders although some diurnal feeding occurs in turbid conditions. Typical prey includes polychaetes, amphipods, nematodes, caridean shrimps, mysids, copepods, isopods, amphipods, ostracods, mollusc, foraminiferans, chironomid larvae, and organic debris (SAFMC 1998).

The Cape Fear Estuary provides food, proper substrate, and shelter for postlarval, juvenile, and subadult penaeid shrimp. White shrimp are less common than pink shrimp in North Carolina estuaries, and brown shrimp do not use estuaries as frequently as either of the other two species. White and pink shrimp enter North Carolina estuaries in June and July where they remain until the fall. Some white and pink shrimp overwinter in the estuaries. In North Carolina, pink shrimp is the most abundant penaeid; in the Cape Fear Estuary, its abundance peaks in September through November.

EFH for eggs, larvae, postlarvae, subadults, and adults of brown, pink, and white shrimp could potentially be impacted by BSEP operations. The thermal plume from the discharge could impact eggs, larvae, and adults while intake operations would be more likely to impact postlarvae, juveniles, and subadults that reside in the estuary. Because penaeid shrimp are opportunistic omnivores, BSEP operations are unlikely to affect their prey. Due to different distributions and habitat requirements of the three penaeid species, it is likely that the pink shrimp would utilize the Cape Fear Estuary more than the brown or white shrimp, and therefore, BSEP operations may have a slightly greater effect on the pink shrimp. Penaeid shrimp was the second most abundant taxon of impinged larvae in 2003 (with peaks in March and April), but the survival rate was over 90 percent (PEC 2003). Likewise, impinged juvenile and adult penaeid shrimp also had a survival rate greater than 90 percent. For brown shrimp, juvenile and adult impingement peaked in June through August, pink shrimp peaks occurred in August, and white shrimp juveniles and adults experienced greatest impingement in July through November. Based on entrainment sampling at BSEP, penaeid shrimp represented 10.5 percent and 2.8 percent of all entrained organisms in 2002 and 2003, respectively, peaking in March, April, and September of 2003 (PEC 2003). The fine-mesh traveling screens have a 66-percent efficiency in reducing entrainment of penaeid shrimp. Because of the high impingement survival rates and the many suitable habitat areas for penaeid shrimp within the Cape Fear Estuary that are not likely to be affected by BSEP operations, it is expected that continued BSEP operations would have a minimal adverse effect on penaeid shrimp EFH for eggs, larvae, postlarvae, juveniles, subadults, and adults of brown shrimp, pink shrimp, and white shrimp.

Rock shrimp - *Sicyonia brevirostris*

For rock shrimp adults, applicable EFH includes nearshore terrigenous and biogenic sandy bottoms at depths of 18-182 m from North Carolina through the Florida Keys. Only occasional association with muddy substrate has been found (SAFMC 1998).

Adult rock shrimp are benthic and eat mostly mollusc, crustaceans, and polychaetes that share their habitat. Rock shrimp prefer sandy bottom habitats ranging from shallow depths to depths greater than 183 m, with the greatest abundance generally occurring in the 25-to-65-m range. Substrate limits habitat selection for rock shrimp more so than salinity or temperature (Kennedy et al. 1977). Although rock shrimp are found off North Carolina, South Carolina, and Georgia, the most productive fisheries land rock shrimp from Florida's offshore waters. In North Carolina, the center of rock shrimp abundance is off Cape Lookout, which is north of Cape Fear (Hill 2005).

Rock shrimp adults in the Atlantic Ocean off Caswell Beach could potentially be impacted by BSEP's thermal plume. However, it is unlikely that BSEP operations would affect rock shrimp EFH because temperature is a less stringent habitat criterion than substrate and because rock shrimp are found in greater abundance in deeper waters. Rock shrimp prey would not be significantly affected by BSEP operations because the adult rock shrimp tend to feed somewhat opportunistically on mollusc, crustaceans, and polychaetes in the area and BSEP operations do not significantly affect local mollusc, crustacean, and polychaete populations. Therefore, continued BSEP operations would have a minimal adverse effect on EFH for adult rock shrimp.

Red drum - *Sciaenops ocellatus*

Red drum EFH is designated from Virginia through the Florida Keys and exists in the vicinity of BSEP for all life stages of red drum (NMFS 2004). Planktonic eggs and larvae have the marine water column in tidal inlets as EFH. Postlarvae, juveniles, and subadults have EFH in the estuarine water column. Specifically, EFH for postlarvae and juveniles includes muddy substrate, SAV, and the interface of marsh and water. EFH for subadults includes muddy substrate, oyster reef, and mangroves. Red drum adult EFH occurs in marine and estuarine water columns in inlets and surf zones up to 50 m deep over substrates of mud or oyster reefs. HAPC for red drum includes tidal inlets and State-designated nursery habitats as well as spawning sites and SAV.

Spawning habitat for red drum includes waters along ocean beaches, tidal inlets, and high-salinity estuaries. For optimal success, the planktonic eggs must be spawned in waters with a salinity range of 25-35 ppt and a temperature range of 22-30 °C (SAFMC 1998). Peak spawning occurs during phases of new and full moons. The Cape Fear Estuary is optimal habitat for first and second year-classes of juvenile red drum as they are found throughout the year in estuaries, bays, rivers, and in grass habitats on the leeward side of barrier islands. However, some juveniles are found along beaches during the late fall through early spring. Juvenile recruitment in North Carolina estuaries peaks during September through November (SAFMC 1998). Red drum adults are less estuarine dependent and migrate seasonally moving north and inshore in the spring and south and offshore in the fall. Red drum eat a variety of prey, including crustaceans, mollusc, and demersal fishes.

All life stages of red drum have potential to occur in the vicinity of the BSEP intake and discharge; however, marine and estuarine water column for adults is likely the only EFH designation to be affected by the discharge. Red drum was not identified as a species commonly impinged or entrained at BSEP (PEC 2003). It is unlikely that BSEP operations would adversely affect red drum prey because the red drum feeds on such a variety of organisms. Because the red drum has EFH in the vicinity of the BSEP intake, continued BSEP operations could have a minimal adverse effect on EFH for red drum eggs, larvae, postlarvae, juveniles, subadults, and adults.

Red snapper - *Lutjanus campechanus*

Red snapper EFH that could occur in the vicinity of BSEP is designated for larvae, postlarvae, and juveniles. EFH for these life stages is the marine water column. The larvae are planktonic, and the postlarvae and juveniles are pelagic. As part of the snapper-grouper complex, applicable red snapper HAPCs near BSEP include SAV, inlets, and State-designated nursery areas.

Red snapper is found in marine waters from the Gulf of Mexico to the Atlantic coast of the U.S. northward to Massachusetts, but rarely occurs north of the Carolinas (SAFMC 1998). Juveniles inhabit shallow marine waters, commonly over sand or mud bottoms whereas adults prefer rocky bottoms. Spawning occurs from April to December with peak activity during June to August in the northwestern Gulf of Mexico and in August to September off southwestern Florida. Larvae, postlarvae, and young juveniles feed on zooplankton. As they grow, red snapper juveniles feed on larger prey, such as shrimp, squid, octopus and crabs (Bester 2006b).

The BSEP discharge could potentially affect EFH for red snapper larvae, postlarvae, and juveniles. Red snapper was not identified as a species commonly impinged or entrained at BSEP (PEC 2003). Because red snapper juveniles feed on estuarine-dependent species, the BSEP intake could affect their prey. Due to the small area of potential effect at the discharge and ample availability of red snapper prey, continued BSEP operations are expected to have a minimal adverse effect on red snapper EFH for larvae, postlarvae, and juveniles.

Gray snapper - *L. griseus*

For the gray snapper, EFH in the vicinity of BSEP has been designated for larvae, postlarvae, juveniles, and adults. For the planktonic larvae, the marine water column is EFH from North Carolina through Florida. Postlarvae and juveniles have EFH designated in the estuarine water column that includes SAV and muddy substrate. Adult gray snapper EFH includes marine and estuarine water columns with hard bottom or SAV. As part of the snapper-grouper complex, applicable gray snapper HAPCs near BSEP include SAV, inlets, and State-designated nursery areas.

All life stages of gray snapper are opportunistic carnivores. Larvae feed on a variety of zooplankton, and juveniles prey upon various organisms, such as small crustaceans and fish, living within SAV habitats. Gray snapper adults are nocturnal predators and eat mostly fish as well as crustaceans, gastropods, and cephalopods.

Gray snapper larvae could be affected by the BSEP intake and discharge. The BSEP intake could adversely affect EFH for postlarvae and juveniles, which prefer SAV and muddy substrate. Gray snapper juveniles are most likely of all life stages to occur commonly near the BSEP intake. Because the nearest hard bottom is beyond the 2000-ac mixing zone, adult gray snapper in the Atlantic Ocean off Caswell Beach are unlikely to be impacted by operation of the intake system. Gray snapper was not identified as a species commonly impinged or entrained at BSEP (PEC 2003). Because gray snapper are opportunistic predators, it is unlikely that BSEP would adversely affect their prey due to the wide variety of diet. Due to the location of the BSEP intake and discharge, continued operation of BSEP would result in a minimal adverse effect on gray snapper EFH for larvae, postlarvae, juveniles, and adults.

White grunt - *Haemulon plumier*

White grunt EFH in the vicinity of BSEP could exist for eggs, larvae, and adults. For the planktonic eggs and larvae, the EFH is the marine water column. Applicable designated EFH for adults is the marine water column from the shore to the 35-m depth contour in areas with SAV. As a species within the snapper-grouper complex, white grunts could have HAPCs near BSEP, such as SAV, inlets, and State-designated nursery areas.

White grunts occur in reef-associated tropical and warm waters, inhabiting irregular bottom areas of the continental shelf from Virginia to Brazil, including Bermuda, the Caribbean, and the Gulf of Mexico, in marine waters ranging from 3 to 40 m deep from the shoreline to the outer reef edge. However, white grunts are rarely found in waters north of South Carolina (FMNH 2006). White grunts are found individually or in dense aggregations during the day on patch reefs, around coral formations, near grass flats, or on sandy bottoms (FishBase 2006). Spawning occurs throughout the year and peaks in the late spring and summer, when females may lay as many as 64,000 eggs.

While larvae feed on plankton, adults feed nocturnally on a wide variety of benthic invertebrates, including crustaceans, small mollusc, and small fishes, by rooting around in the sand and shell hash between rocky ledges and at the bases of coral formations.

Because white grunts are rare north of South Carolina, areas near the BSEP intake and discharge likely do not provide much habitat for white grunt eggs, larvae, and adults. White grunt was not identified as a species commonly impinged or entrained at BSEP (PEC 2003). Therefore, it is expected that continued BSEP operations would have a minimal adverse effect on white grunt EFH for eggs, larvae, and adults.

Blueline tilefish - *Caulolatilus microps*

EFH for blueline tilefish eggs is found in the vicinity of BSEP. The designated EFH is the marine water column for the planktonic eggs. As a member of the snapper-grouper complex, the blueline tilefish has HAPCs in the vicinity of BSEP; the HAPCs include SAV, inlets, and State-designated nursery areas. However, because EFH in the area is designated only for eggs, it is unlikely that the snapper-grouper HAPC in the area applies to blueline tilefish eggs.

The blueline tilefish is a benthic species found in water ranging from 73-238 m deep, from Virginia to the Campeche Banks of Mexico (SAFMC 1998). Like others in the snapper-grouper complex, blueline tilefish adults prefer irregular bottom with sand, mud, and shell hash as substrate. Bottom water temperatures of 15 to 23 °C are preferred. Spawning typically occurs from May to September, and females may lay more than four million free-floating eggs. Because only eggs have designated EFH in the study area, prey species are not considered for the blueline tilefish.

Although it is possible that blueline tilefish eggs could be affected by the BSEP discharge, it is highly unlikely that the planktonic eggs would be carried to the waters near Caswell Beach due to the species preference for much deeper waters. Blueline tilefish was not identified as a species commonly impinged or entrained at BSEP (PEC 2003). Therefore, BSEP operations would have only a very minimal adverse effect on EFH for blueline tilefish eggs.

Bluefish - *Pomatomus saltatrix*

EFH for bluefish eggs, larvae, juveniles, and adults exists in the vicinity of BSEP. Because all life stages of bluefish are pelagic, the marine water column over the continental shelf from Cape

Hatteras through Key West, Florida, is designated EFH for eggs, larvae, juveniles, and adults (NMFS 2006a). Specifically, eggs inhabit waters at mid-shelf depths, and larvae inhabit waters greater than 13.7 m deep. Neither eggs nor larvae are typically found in inshore waters. Bluefish eggs and larvae are usually found in waters with temperatures greater than 17.8 °C and salinities greater than 30 ppt. EFH for juveniles and adults also includes the estuarine water column of all major estuaries from Penobscot Bay, Maine, to St. Johns River, Florida; therefore, the Cape Fear Estuary is EFH for bluefish juveniles and adults.

Bluefish eggs are usually found from April through August, and larvae are typically collected from April through September (NMFS 2006a). Bluefish are seasonal migrating species moving to the Middle Atlantic Bight during spring and south and further offshore during fall. Juveniles are found in the mixing zones of mid-Atlantic estuaries from May through October and in the mixing zones of south Atlantic estuaries between March and December. Optimum conditions for pelagic juveniles (summer cohort) include temperatures of 15 to 20°C and salinities of 31 to 36 ppt, and summer cohort juveniles prefer temperatures of 20 to 30°C and salinities of 23 to 33 ppt (NMFS 1999a). Bluefish adults are found in the mixing zones of mid-Atlantic estuaries between April and October and in the mixing zones of south Atlantic estuaries from May through January. The Cape Fear Estuary could be considered a mid-Atlantic or south Atlantic estuary. Adult bluefish prefer salinities greater than 25 ppt.

Bluefish are known to be voracious, opportunistic predators; because bluefish will eat almost anything, it is unlikely that BSEP operations would affect bluefish prey. The thermal plume at the BSEP discharge could adversely affect a tiny portion of marine EFH for bluefish eggs, larvae, juveniles, and adults. Also, operations at the BSEP intake that withdraw water from the estuarine water column could adversely affect EFH for juveniles and adults. However, bluefish was not identified as a species commonly impinged or entrained at BSEP (PEC 2003), and the local bluefish population does not appear to be declining. Therefore, continued operations of BSEP would have a minimal adverse effect on EFH for bluefish eggs, larvae, juveniles, and adults.

Summer flounder - *Paralichthys dentatus*

Summer flounder EFH for larvae, juveniles, and adults is designated as the water columns in estuaries and over the continental shelf from Albemarle Sound, North Carolina, through St. Andrew and Simon Sounds (NMFS 2004). SAV, either in clump or bed forms, is identified as EFH and as a HAPC for larval, juvenile, and adult summer flounder (NMFS 2006a).

Summer flounder are common in coastal and estuarine waters from Nova Scotia to Florida; the highest abundances are associated with waters of the Middle Atlantic Bight (NMFS 1999b). Summer flounder exhibit a strong seasonal migration pattern that finds them in shallow coastal and estuarine waters during the spring and summer, and in deeper offshore waters during the fall and winter. The areas of abundance for larvae are 12-50 mi from shore at depths of 9-70 m (NMFS 2006a). Historical research indicates larvae have been recorded in the Cape Fear River between March and May (NMFS 2006b). Estuaries serve as nursery areas to juveniles, with preferred water temperatures above 2.8 °C and preferred salinities 10 to 30 ppt (NMFS 2006b). Adults typically inhabit estuarine and coastal waters during warm months and move offshore during cold months. Juvenile and adult summer flounder are opportunistic feeders; juveniles appear to prefer crustaceans and polychaetes, while larger individuals appear to prefer crustaceans and fish.

The primary impacts of BSEP operations on summer flounder EFH where impacts to the marine and estuarine water column EFH due to impingement of juveniles and adults on BSEP's traveling screens, and thermal impacts associated with the BSEP's thermal discharges are possible. However, although summer flounder has been found in BSEP sampling studies, it is not one of the most commonly impinged or entrained species at BSEP (CP&L 1980, 1985, & 1993; PEC 2003). Also, 93.2 percent of flounder larvae and 71.1 percent of flounder juveniles and adults survive impingement (PEC 2003). Although summer flounder prey have been impinged and entrained at BSEP, the opportunistic nature of summer flounder feeding indicates that BSEP operations would not limit prey availability. Thus, continued BSEP operations are expected to have a minimal adverse effect on EFH for summer flounder larvae, juveniles, and adults.

Cobia - *Rachycentron canadum*

EFH for cobia larvae, postlarvae, juveniles, and adults includes estuarine and marine water columns near sandy shoals, barrier islands, and in areas from the surf zone to the shelf break (NMFS 2004). Cobia EFH is designated in State-designated nursery areas, bays, estuaries, coastal inlets, and seagrass beds with high salinity. Also, as a member of the coastal pelagic group, the area of sandy shoals at Cape Fear is designated as a geographically defined HAPC for cobia.

Cobia generally prefer water temperatures of 20-30 °C and migrate south and offshore during cold months (Bester 2006a). They are attracted to any sort of structure in open water, which could include BSEP's discharge pipe on the bottom off Caswell Beach. Cobia typically swim in schools, and they spawn in large aggregations. Off North Carolina, spawning typically occurs in May and June. Adult cobia are carnivorous predators and scavengers. Like all coastal migratory pelagics, cobia move according to prey abundance. While they will eat most organisms, they prefer estuarine-dependent organisms, such as crabs and fishes.

Larval, postlarval, juvenile, and adult cobia in the Atlantic Ocean off Caswell Beach could potentially be impacted by the small thermal plume created by BSEP's discharge. Larvae, postlarvae, juveniles, and adults in the Cape Fear Estuary could potentially be impacted by operation of the intake system. However, cobia was not identified as a species commonly impinged or entrained at BSEP (PEC 2003). Although cobia prefer estuarine-dependent prey that could be affected by BSEP operations, it is unlikely that BSEP operations would affect all prey distribution in the Cape Fear Estuary because cobia feed on such a large variety of organisms. Cobia HAPC at Cape Fear is likely concentrated on the ocean side of the barrier islands. The BSEP intake is within the estuary on the leeward side of the barrier islands. Therefore, continued BSEP operations would have a minimal adverse effect on EFH for cobia larvae, postlarvae, juveniles, and adults.

King mackerel - *Scomberomorus cavalla*

EFH for king mackerel juveniles and adults includes the marine water column near sandy shoals, barrier islands, and in areas from the surf zone to the shelf break (NMFS 2004). King mackerel EFH includes the South Atlantic Bight, coastal inlets, and nearshore waters. Like cobia, king mackerel is part of the coastal migratory pelagic group, which has HAPC specifically designated at the sandy shoals at Cape Fear.

King mackerel juveniles swim in schools while adults are solitary (CBP 2006). King mackerel generally prefer warm waters (no lower than 20 °C), thus migrating south in winter months. Outer reefs and coastal waters are preferred habitats for the king mackerel, and preferred depths are in the range of 23-34 m (Perrotta 2006). Juveniles eat small estuarine-dependent fish and invertebrates; adults prey on larger estuarine-dependent, schooling fish as well as some shrimp, crustaceans, and squid. King mackerel spawn in offshore waters.

Juvenile and adult king mackerel in the Atlantic Ocean off Caswell Beach could potentially be impacted by the thermal plume but would likely exhibit behavioral avoidance. King mackerel was not identified as a species commonly impinged or entrained at BSEP (PEC 2003). King mackerel prey is estuarine-dependent and could be affected by the BSEP intake. However, because king mackerel generally prefer deeper waters and because they feed on a variety of prey, BSEP operations would have only a minimal adverse effect on EFH for king mackerel juveniles and adults.

Spanish mackerel - *S. maculatus*

EFH for Spanish mackerel includes estuarine and marine water columns for juveniles and the marine water column for adults; Spanish mackerel EFH is designated at depths of 9-84 m. Juvenile EFH includes waters in offshore, beach, and estuarine areas, such as near sandy shoals, barrier islands, and in areas from the surf zone to the shelf break (NMFS 2004). Adult Spanish mackerel are pelagic and less dependent on protected areas. Spanish mackerel EFH includes coastal inlets, and nearshore waters. Like cobia and king mackerel, the Spanish mackerel is part of the coastal migratory pelagic group, which has HAPC specifically designated at the sandy shoals at Cape Fear.

Juveniles can tolerate a wide range of salinity, from 13-34 ppt, and they are most abundant in the Cape Fear Estuary during May through August when salinities are increasing (SAFMC 1998). Adults prefer the marine environment are highly migratory, generally moving northward (up to the Gulf of Maine) each spring, spending the summer in northern range areas, and migrating south in fall to the northern Gulf of Mexico. Spanish mackerel are schooling fish and prefer warm waters (most abundant in waters of 21-31 °C); Spanish mackerel are rare in waters below 17.8 °C (CBP 2006). The diet for juveniles and adults consists primarily of fish (engraulids and clupeids), crustaceans, gastropods, and squid.

Juvenile and adult Spanish mackerel EFH could potentially be affected due to BSEP's thermal plume in the Atlantic Ocean off Caswell Beach, but they are likely to exhibit behavioral avoidance. Juvenile EFH in the Cape Fear Estuary could be affected by operation of the BSEP intake system. However, Spanish mackerel was not identified as a species commonly impinged or entrained at BSEP (PEC 2003). Some Spanish mackerel prey is estuarine-dependent and could be affected by the BSEP intake, but Spanish mackerel feed on a variety of species so this impact is expected to be minor. BSEP operations would have a minimal adverse effect on EFH for Spanish mackerel juveniles and adults.

Spiny dogfish - *Squalus acanthias*

Spiny dogfish EFH is designated in the marine water column in shelf waters 10-400 m deep for juveniles and 10-450 m deep for adults (NMFS 2004). EFH for spiny dogfish juveniles and adults also includes inshore estuaries (where higher salinities are preferred) and outer shelf and coastal waters, with temperatures ranging 2.78 to 27.8 °C.

Spinal dogfish are highly migratory based on water temperatures, moving northward up the Atlantic coast past Cape Cod, Massachusetts, in the summer. In the fall and winter, the species move south past Long Island to as far south as North Carolina (NMFS 2006b). Juveniles are generally found at depths of 10-390 m, and adults at 10-450 m. Spiny dogfish are typically epibenthic but can occasionally be found throughout the water column. Spiny dogfish are voracious opportunistic feeders attacking prey smaller than themselves (cod, jellyfish, shrimp).

The BSEP intake and thermal discharge plume have potential to adversely affect juvenile and adult spiny dogfish EFH. However, it is unlikely that BSEP intake operations are adversely affecting juvenile and adult spiny dogfish because the species has not been reported to be commonly entrained or impinged (CP&L 1980, 1985, & 1993; PEC 2003). The thermal discharge is unlikely to affect spiny dogfish juveniles and adults because the affected area makes up a tiny portion of their EFHs and because they would exhibit behavioral avoidance if water temperatures exceed their preference range. BSEP operations are unlikely to have an effect on spiny dogfish prey availability since they are opportunistic feeders. Therefore, continued BSEP operations would have a minimal adverse effect on EFH for spiny dogfish juveniles and adults.

Scalloped hammerhead shark - *Sphyrna lewini*

EFH could exist near BSEP for scalloped hammerhead shark neonates and juveniles. The designated EFH includes the marine water column from shore to the 200-m isobath. Nurseries are usually in shallow coastal waters. The scalloped hammerhead shark prefers tropical waters and swims in schools, which makes it highly vulnerable to overfishing. Scalloped hammerheads prey on bony fishes and cephalopods (Taylor et al. 1997).

Scalloped hammerhead shark EFH may exist near the BSEP intake and discharge. Scalloped hammerhead sharks have not been identified in impingement and entrainment samples at BSEP (PEC 2003). Neonate and juvenile scalloped hammerhead sharks in the Atlantic Ocean off Caswell Beach could potentially be impacted by the thermal plume, but like the spiny dogfish, it is likely that behavioral avoidance would preclude any adverse effects on scalloped hammerhead sharks. Because scalloped hammerhead feeds on a variety of species, it is unlikely that BSEP operations would affect their prey. Therefore, continued BSEP operations would have a minimal adverse effect on EFH for neonate and juvenile scalloped hammerhead sharks.

Dusky shark - *Carcharhinus obscurus*

EFH for dusky shark neonates and juveniles is considered shallow (less than 200 m deep) coastal waters, inlets, and estuaries from New Jersey to Cape Hatteras, North Carolina (NMFS 2006b). Therefore, dusky shark EFH for juveniles may exist near the BSEP intake and discharge. Shallow waters and estuaries are used as nursery areas for young sharks. It appears that the young sharks are tolerant of both temperature and salinity extremes common to estuaries. The juvenile dusky shark diet is assumed to be similar to adults and includes a variety of invertebrates and fish, including other sharks (Taylor et al. 1997).

Dusky shark was not a species identified as commonly impinged at BSEP (CP&L 1980, 1985, & 1993; PEC 2003), and the species would exhibit behavioral avoidance if the thermal discharge plume exceeds the dusky shark's preferred temperature range. Also, BSEP operations would not limit prey availability to dusky sharks because of the diversity of their diet. Therefore, continued BSEP operations would have a minimal adverse effect on dusky shark EFH for neonates and juveniles.

Sandbar shark - *Carcharhinus plumbeus*

EFH is designated for sandbar sharks in coastal waters to 25 m in depth for neonates and juveniles and to 50 m for adults. EFH requirements include temperatures higher than 21° C and salinities greater than 22 ppt (NMFS 2006b).

Sandbar sharks are bottom-dwelling and represent one of the most numerous shark species in the western Atlantic. Temperature and salinity preferences for various life stages are assumed to be typical of estuaries. Sandbar sharks are common in sandy areas behind the surf zone (Taylor et al. 1997). They typically swim near the bottom and frequent large bays and estuaries. Sandbar sharks are opportunistic feeders, and prey items commonly include small fish, molluscs, and crustaceans.

BSEP operations are unlikely to affect sandbar shark EFH. The sandbar shark is not identified as a species routinely impinged or entrained at BSEP (CP&L 1980, 1985, & 1993; PEC 2003). Although sandbar sharks are likely to be in the area of the BSEP discharge, the species would exhibit behavioral avoidance if necessary to prevent adverse impacts from the thermal plume. Finally, BSEP operations would not affect sandbar shark prey distribution due to its opportunistic feeding habits. Therefore, BSEP operations would have a minimal adverse effect on sandbar shark EFH for neonates, juveniles, and adults.

Tiger shark - *Galeocerdo cuvieri*

EFH is designated for tiger sharks in coastal waters to 200 m in depth for neonates, to 100 m for juveniles, and out to the Gulf Stream for adults. EFH exists from Cape Canaveral, Florida, to offshore Montauk, Long Island, New York (NMFS 2006b). Temperature and salinity preferences are not known for this species, but tiger sharks are found in a variety of estuarine and marine habitats. Tiger sharks are opportunistic predators and scavengers and will eat almost anything. They feed around dusk in shallow areas, such as lagoons and estuaries.

BSEP operations are unlikely to affect tiger shark EFH. The tiger shark is not identified as a species routinely impinged or entrained at BSEP (CP&L 1980, 1985, & 1993; PEC 2003). In addition, the species will exhibit behavioral avoidance if necessary to escape the thermal plume. Finally, BSEP operations would not affect tiger shark prey distribution due to its opportunistic and scavenging feeding habits. Therefore, BSEP operations would have a minimal adverse effect on tiger shark EFH for neonates, juveniles, and adults.

Sand tiger shark - *Odontaspis taurus*

EFH is designated for sand tiger shark neonates, juveniles, and adults in coastal waters to 25 m in depth from Barnegat Inlet, New Jersey to Cape Canaveral, Florida (NMFS 2006a). Sand tiger sharks are common in tropical and warm temperate coastal waters and are frequently found in very shallow waters (less than four m deep). Sand tiger sharks feed on fish, small sharks, rays, squid, and crustaceans (Taylor et al. 1997).

BSEP operations are unlikely to affect sand tiger shark EFH. The sand tiger shark is not identified as a species routinely impinged or entrained at BSEP (CP&L 1980, 1985, & 1993; PEC 2003). In addition, the species would exhibit behavioral avoidance if necessary to escape the thermal plume. Finally, BSEP operations would not affect sand tiger shark prey distribution due to the large variety of prey within its diet. Therefore, BSEP operations would have a minimal adverse effect on sand tiger shark EFH for neonates, juveniles, and adults.

Bonnethead shark - *Sphyrna tiburo*

EFH is designated for neonate, juvenile, and adult bonnethead sharks. Neonate and juvenile EFH includes inlets, estuaries, and shallow waters (less than 25 m deep) from Cape Fear to West Palm Beach, Florida (as well as water between Miami and the Florida Keys). Adult EFH for bonnetheads has the same requirements, but the range extends from Cape Fear to Cape Canaveral, Florida (and includes the waters of the Florida Keys) (NMFS 2006b).

Bonnethead sharks prefer warm waters over sandy or muddy substrates. Bonnetheads are abundant in surf zones, estuaries, bays, and shelf waters (Taylor et al. 1997). Bonnethead sharks typically eat crabs, shrimp, bivalves, snails, cephalopods, and some small fish. They give birth in shallow bays and estuaries.

BSEP operations are unlikely to affect bonnethead shark EFH. The bonnethead shark is not identified as a species routinely impinged or entrained at BSEP (CP&L 1980, 1985, & 1993; PEC 2003). In addition, the species would exhibit behavioral avoidance if necessary to escape the thermal plume. Finally, although BSEP operations do entrain and impinge some bonnethead shark prey, the broad diet would allow for bonnetheads to continue feeding without any detectable impacts. Therefore, BSEP operations would have a minimal adverse effect on bonnethead shark EFH for neonates, juveniles, and adults.

Atlantic sharpnose shark - *Rhizoprionodon terraenovae*

EFH is designated for Atlantic sharpnose sharks in coastal waters for neonates, juveniles, and adults in shallow coastal areas including bays and estuaries. For neonates and juveniles, EFH requirements include shallow waters ranging from less than 5 m deep to 25 m deep from Cape Hatteras, North Carolina, to Daytona Beach, Florida. Off North Carolina, juvenile EFH requirements also include waters up to 50 m deep. Adult Atlantic sharpnose shark EFH in the range from Cape May, New Jersey, to the border between North and South Carolina requires water depths of 25-100 m (NMFS 2006a).

Atlantic sharpnose shark neonates typically prefer water temperatures of 24-30.7 °C and salinities of 22.8-33.7 ppt (NMFS 2006b). Atlantic sharpnose sharks are common in shelf waters and can tolerate estuarine conditions. Atlantic sharpnose sharks prey on small fishes and invertebrates (Taylor et al. 1997).

BSEP operations are unlikely to affect Atlantic sharpnose shark EFH. The Atlantic sharpnose shark is not identified as a species routinely impinged or entrained at BSEP (CP&L 1980, 1985, & 1993; PEC 2003). In addition, the species would exhibit behavioral avoidance if necessary to escape the thermal plume. Finally, BSEP operations may entrain and impinge Atlantic sharpnose shark prey, but impacts have not been detected at population levels. Plenty of prey exists in the area for Atlantic sharpnose sharks. Therefore, BSEP operations would have a minimal adverse effect on Atlantic sharpnose shark EFH for neonates, juveniles, and adults.

7.0 Impact Avoidance, Minimization, and Mitigation Measures

Operation of the BSEP's once-through cooling system could adversely affect EFH in the Cape Fear Estuary and in the Atlantic Ocean off Caswell Beach. The NPDES permit allows the BSEP cooling system to operate if it does not exceed specified entrainment, impingement, and discharge limits. The NPDES permit also requires mitigation measures, which are in place at BSEP.

BSEP currently has features designed to mitigate potential impacts on estuarine and marine biota by operation of the plant's cooling system. As prescribed in the NPDES permit, the intake volume is limited according to freshwater flow rates in the Cape Fear River (see section 4.2). Also, at the entrance of the intake canal, the diversion structure with trash racks and 3/8-in.-mesh screens prevents large organisms from entering the intake canal. Typically, the reproducing population of most species is composed of larger individuals; therefore, the diversion structure has excluded sexually mature individuals from the intake canal, allowing them the opportunity to reproduce in the estuary.

Cooling water is withdrawn through a combination of eight bays (four for each unit), each of which has a trash rack, traveling screens, and an intake pump. Typically, traveling screens at steam electric power plants employ 3/8-in.-mesh screens. The finer 1-mm-mesh screens used at BSEP reduce entrainment and require more frequent rotation and cleaning. Organisms impinged on the traveling screens are washed into a fish-return flume that leads to a holding basin before being released to Walden Creek, a part of the Cape Fear River watershed. As discussed in Section 5, survival of impinged organisms in the fish-return flume has been shown to be substantial. Biological monitoring and impingement and entrainment studies conducted at BSEP indicate that the existing mitigation measures greatly reduce adverse effects on marine and estuarine species and their EFHs. The NRC staff has not identified additional cost-effective mitigation measures that would further reduce the impacts of continued operation of BSEP during the extended period of operation.

8.0 Conclusions

The potential impacts of BSEP on Federally managed species and their EFHs that occur in the vicinity of BSEP have been evaluated. Known distributions and records of those species, the ecological impacts of the operational and maintenance activities of BSEP, and the mitigation measures that CP&L has implemented to avoid, minimize, and mitigate impacts to the various life history stages of these species have been considered in this EFH assessment.

Early life stages of estuarine and marine spawners could be entrained with the cooling water into the plant; however, the NPDES permit limit on intake volume during the winter months and the survival of organisms retained on the fine-mesh traveling screens minimize entrainment.

Estuarine juveniles and adults are expected to experience only very minor impacts from impingement caused by the operation of the diversion structure and high survival rate via the fish-return flume. Juveniles and adults in the marine water column are not expected to frequent the area of the intake diversion structure, where salinities vary from 13 ppt to 30 ppt, depending on downstream freshwater flow in the Cape Fear River. Therefore, they would not be affected significantly by impingement. Expected potential impacts on juveniles and adults in oceanic habitats from the heated discharge would be negligible because of the small area of the mixing zone, the shallow depth of only 3 m near the discharge (most habitat preferences begin at 6-9 m), and avoidance behavior of fishes. The size of the marine water column affected by the BSEP discharge is only a tiny fraction of available EFH of its kind. Because the nearest live hard bottom EFH is miles away from the discharge, the thermal plume would not affect live hard bottom EFH for species managed by the South Atlantic Fishery Management Council.

The Cape Fear River Estuary and ocean waters off Cape Fear include many categories of EFH for managed species. While some aspects of BSEP operation may have minimal adverse impacts to EFH, it is unlikely that these impacts would be significant or cumulative and result in a significant impact to Federally managed species or their EFHs. Population studies conducted by CP&L in 2001 and 2002 demonstrate no detectable decline in abundance for any studied species or change in the species composition within the Cape Fear River Estuary or offshore waters (PEC 2003). Therefore, the NRC staff finds that there is no evidence that Federally managed species or their EFHs have been adversely impacted by operation of BSEP, and we conclude that continued operation of BSEP over the 20-year license renewal term would have a minimal adverse effect on EFH associated with Federally managed species found within the vicinity of the BSEP intake and discharge structures.

9.0 References

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