UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
NORTHEAST REGION
One Blackburn Drive
Gloucester, MA 01930-2298

AUG - 2 2007

Pao-Tsin Kuo, Director
Division of License Renewal
Office of Nuclear Reactor Regulation
United States Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Dear Mr. Kuo,

This is in response to your letter dated July 12, 2007 requesting documents for the consolidated record regarding the Federal consistency review for the license renewal of the Oyster Creek Generating Station (OCNGS). The Nuclear Regulatory Commission (NRC) has requested documents reflecting all decisions made or actions taken by NOAA's National Marine Fisheries Service (NMFS) related to the proposed renewal of the OCNGS license and or the CZMA consistency determination, including any supporting documentation or other documents relevant to such decision documents. Please find enclosed documents relating to consultations conducted pursuant to the Endangered Species Act (ESA) of 1973, as amended, and the Essential Fish Habitat provisions of the Magnuson-Stevens Fishery Conservation and Management Act (MSA).

Endangered Species Act Consultation

In November 2006, NMFS completed a consultation pursuant to Section 7 of the ESA with NRC on the effects of the proposed license renewal on threatened and endangered sea turtles. Consultation concluded with the issuance of a Biological Opinion (Opinion) dated November 21, 2006. NMFS has enclosed several documents related to the development of this Opinion. In addition to the final Opinion and correspondence related to the consultation, we have enclosed copies of previously issued Opinions regarding the ongoing operation of the OCNGS. Additionally, we have enclosed reports related to the incidental take of sea turtles at the facility. NMFS relies on the best available commercial and scientific information in the development of consultation documents. We have included the most relevant scientific papers and references in this submittal. If there are additional papers or literature referenced in the Opinion that you would find helpful for the consolidated record, we will provide those upon request. Please note that for two large documents submitted by NRC to NMFS (i.e., the draft Generic Environmental Impact Statement for License Renewal of Nuclear Plants Supplement 28 regarding OCNGS dated June 2006 and the summary of public meetings dated August 10, 2006), NMFS has included only the cover page and executive summary. Complete copies of these documents will be submitted to NRC upon request. Should you have any questions regarding the documents related to the ESA consultation, or to request additional documents referenced in the November 21, 2006 Opinion, please contact Julie Crocker ((978)281-9300 x6530) or Mary Colligan ((978)281-9116) of my staff.

Essential Fish Habitat Consultation
In September 2006, NMFS completed a consultation pursuant to the Section 305 (b)(2) of the MSA with NRC on the effects of the proposed license renewal on the essential fish habitat (EFH). The NRC prepared an EFH assessment that was included as Appendix E of the draft supplement 28 to NUREG-1437, "Generic Environmental Impact Statement for the License Renewal of Nuclear Power Plants." A copy of NRC's EFH assessment is enclosed. Consultation concluded with the issuance of conservation recommendations to minimize impacts to EFH pursuant to Section 305 (b)(4)(A) of the MSA in a letter dated September 28, 2006 to Mr. Frank Gillespie, Director, Division of License Renewal of the NRC. A copy of this letter is enclosed. Also, enclosed is a copy of comments provided to the New Jersey Department of Environmental Protection in response to the public notice requesting comments on the renewal of the New Jersey Pollutant Discharge Elimination system (NJPDES) Discharge to Surface Waters (DSW) Permit NJ0005550 issued to AmerGen, LLC., for the Oyster Creek Generating Station. The MSA does not require state agencies to consult with NMFS regarding EFH. Pursuant to the EFH regulations at 50 CFR 600.925 (a)(c), NMFS is required to use existing coordination procedures or establish new procedures to determine the most appropriate method for providing EFH conservation recommendations to state agencies. The NJPDES DSW permit renewal was the appropriate means of providing EFH conservation recommendations to the State of New Jersey. A list of references used in the preparation of our EFH conservation recommendations is enclosed. The second document listed (Northeast Fisheries Science Center Document 03-06) is over 400 pages and a full copy was not included in this submittal. The entire document will be provided upon request or can be downloaded from the NMFS Northeast Fishery Science Center's publication website at: http://www.nefsc.noaa.gov/nefsc/publications/crd/crd0306/crd0306.pdf. Should you have any questions regarding the documents related to the MSA consultation please contact Karen Greene ((732) 872-3023) or Stanley W. Gorski ((732) 872-3037) of my staff.

Please contact the staff members identified above if you have any questions regarding this submittal or to request additional documents.

Sincerely,

Patricia A. Kurkul
Regional Administrator

Enclosures

Cc: Crocker, Colligan – F/NER3
Greene, Gorski, Colosi – F/NER4
Williams - GCNE
Kaiser – NOAA
Lindow – F

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

October 12, 2005

Patricia A. Kurkul, Regional Administrator
NOAA's National Marine Fisheries Service
Northeast Regional Office
One Blackburn Drive
Gloucester, MA 09130-2298

SUBJECT: REQUEST FOR LIST OF PROTECTED SPECIES AND ESSENTIAL FISH HABITAT WITHIN THE AREA UNDER EVALUATION FOR OYSTER CREEK NUCLEAR GENERATING STATION LICENSE RENEWAL

Dear Ms. Kurkul:

The U.S. Nuclear Regulatory Commission (NRC) is reviewing an application submitted by AmerGen Energy Company, LLC (AmerGen) for the renewal of the operating license for the Oyster Creek Nuclear Generating Station (OCNGS). OCNGS is a single-unit nuclear plant located in Lacey Township in Ocean County, New Jersey. As part of the review of the license renewal application, the NRC is preparing a Supplemental Environmental Impact Statement (SEIS) under the provisions of the National Environmental Policy Act (NEPA) of 1969, as amended. The SEIS includes an analysis of pertinent environmental issues, including endangered or threatened species and impacts to marine resources and habitat. This letter is being submitted under the provisions of the Endangered Species Act of 1973, as amended, the Fish and Wildlife Coordination Act of 1934, as amended, and the Sustainable Fisheries Act of 1996.

AmerGen stated that it has no plans to alter current operations over the license renewal period and that OCNGS operating under a renewed license would use existing plant facilities and transmission lines and would not require additional construction or disturbance of new areas. Any maintenance activities would be limited to previously disturbed areas.

OCNGS is situated on approximately 800 acres of land in the coastal pine barrens of New Jersey approximately 9 miles south of Toms River, New Jersey. The property is on the western shore of Barnegat Bay. East of U.S. Highway 9 the northern site boundary is the South Branch of Forked River, and the southern site boundary is Oyster Creek. West of U.S. Highway 9 the site boundary is defined by the manmade intake and discharge canals (See Enclosed Maps).

OCNGS employs a once-through heat dissipation system designed to remove waste heat from the condensers. The circulating water system includes the intake canal, an intake structure divided into two bays, circulating water pumps, condensers, dilution pumps, discharge pipes, and discharge canal. The purpose of the dilution pumps is to decrease the attractiveness of the heated discharge to migratory marine species during the spring and fall, and to reduce thermal stress on organisms in the discharge canal during the summer. An angled boom in the intake canal immediately in front of the intake prevents large mats of eelgrass and algae from clogging the intake system. Barnegat Bay is the plant's cooling water source and heat sink. Cooling water is drawn from Barnegat Bay through the South Branch of Forked River and into a

150-foot-wide intake canal dredged to a depth of 10 feet. The circulating water is returned to the 150-foot-wide discharge canal and from there flows to Oyster Creek and back to Barnegat Bay. Depths in the South Branch of the Forked River, canals, and lower reaches of Oyster Creek are maintained by periodic dredging.

The transmission lines in the scope of NRC's environmental review for license renewal are those that were originally constructed for the specific purpose of connecting the plant to the transmission system. A single 230-kilovolt transmission line was built to connect OCNGS to the electric grid. It is a double circuit line hung on a single set of towers that runs 11.1 miles from the OCNGS 230 kilovolt Substation to the Manitou Substation near Toms River. Beyond the OCNGS substation transformer-side disconnects, the line is owned and operated, and corridor easements held, by FirstEnergy, an Ohio utility. The transmission line corridor is 240 feet wide and approximately parallels the New Jersey State Parkway, occupying about 320 acres. The corridor passes through land that is primarily pine forest and swamp forest. Approximately 1 mile of the line passes through Double Trouble State Park. The line is in Ocean County and crosses numerous county roads and the New Jersey State Parkway. FirstEnergy plans to maintain this transmission line, which is integral to the larger transmission system, indefinitely. The transmission line will remain a permanent part of the transmission system after OCNGS is decommissioned. The transmission line and site boundary are identified in the enclosed maps.

To support the SEIS preparation process and to ensure compliance with Section 7 of the Endangered Species Act, the NRC requests a list of endangered, threatened, candidate, and proposed species, and designated and proposed critical habitat under the jurisdiction of the National Marine Fisheries Service that may be in the vicinity of the OCNGS site and its transmission line corridors. The most recent formal consultation for the continued operation of OCNGS was completed on September 22, 2005. However, this letter requesting consultation relates specifically to the NRC's review of AmerGen's license renewal application for OCNGS.

In addition, please provide any information you consider appropriate under the provisions of the Fish and Wildlife Coordination Act. Also in support of the SEIS preparation and to ensure compliance with Section 305 of the Magnuson-Stevens Fishery Conservation and Management Act, the NRC requests a list of essential fish habitat that has been designated in the vicinity of the OCNGS site and its associated transmission line corridors.

The NRC staff plans to hold two public NEPA scoping meetings on November 1, 2005, at the Quality Inn located at 815 Route 37 in Toms River, New Jersey. You and your staff are invited to attend the public meetings. The first session will convene at 1:30 p.m. and will continue until 4:30 p.m., as necessary. The second session will convene at 7:00 p.m., with a repeat of the overview portions of the meeting, and will continue until 10:00 p.m., as necessary. Your office will also receive a copy of the draft SEIS along with a request for comments. The anticipated publication date for the draft SEIS is June 2006.

P. Kurkul - 3 -

If you have any questions concerning OCNGS, the license renewal application, or other aspects of this project, please contact the NRC's Senior Environmental Project Manager, Dr. Michael Masnik, at 301-415-1191 or by e-mail at MTM2@nrc.gov.

Sincerely,

Pao-Tsin Kuo, Program Director
License Renewal and Environmental Impacts Program
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket No.: 50-219

Enclosures: As stated

cc w/encls.: See next page

ESSENTIAL FISH HABITAT ASSESSMENT FOR RENEWAL OF THE OYSTER CREEK NUCLEAR GENERATING STATION OPERATING LICENSE

1.0 INTRODUCTION

The Magnuson-Stevens Fishery Conservation and Management Act, (FCMA) which was reauthorized and amended by the Sustainable Fisheries Act of 1996, sets forth the essential fish habitat (EFH) provisions designed to protect important habitats of Federally managed marine and anadromous fish species. The Act requires the eight regional fishery management councils to describe and identify EFH in their respective regions, to specify actions that would conserve and enhance EFH, and to minimize the adverse effects of fishing on EFH. Pursuant to the Act, Congress has defined EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity". Federal agencies that fund, permit, or undertake activities that may adversely affect EFH are required to consult with the National Marine Fisheries Service (NMFS) regarding the potential effects of their actions on EFH, and respond in writing to NMFS's conservation recommendations. For the purpose of consultation, an adverse effect includes any impact that reduces the quality and/or quantity of EFH. The consultation document must include the following information:

- A description of the proposed action;
- An analysis of the potential adverse effects of the action on EFH and the managed species;
- The Federal agency's conclusions regarding the effects of the action on EFH; and
- Proposed mitigation, if applicable.

On July 22, 2005, the U.S. Nuclear Regulatory Commission (NRC) received an application from AmerGen Energy Company, LLC (AmerGen), for renewal of the operating license (OL) of the Oyster Creek Nuclear Generating Station (OCNGS), which expires on April 9, 2009. As part of the application, AmerGen submitted an Environmental Report (ER) (AmerGen 2005a) prepared in accordance with the requirements of Title 10, Part 51, of the *Code of Federal Regulations* (10 CFR Part 51).

On September 22, 2005, the NRC staff published (NRC 2005a) a Notice of Intent to prepare a plant-specific supplement to the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2 (NRC 1996,1999). During the development of the Supplemental Environmental Impact Statement (SEIS), the NRC staff visited the site, met with members of Federal and State regulatory agencies, spoke to local citizens, interviewed individuals who had conducted environmental research in Oyster Creek, Forked River, or Barnegat Bay, and reviewed a variety of technical reports, journal articles, and other relevant information to determine whether license renewal would result in adverse environmental impacts. This information and other sources relevant to EFH issues were

consulted during the development of this document. This EFH assessment has been developed to fulfill the NRC requirement under the FCMA for the OCNGS license renewal review.

2.0 PROPOSED FEDERAL ACTION

The proposed Federal action is renewal of the OL for OCNGS, a nuclear power plant that is located in eastern New Jersey adjacent to Barnegat Bay. OCNGS is a single-unit plant with a boiling-water reactor and steam turbine manufactured by General Electric. The reactor has a design power level of 1930 megawatts thermal (MW[t]) and a net power output of 640 megawatts electric (MW[e]). Plant cooling is provided by a once-through cooling system that draws cooling water from Barnegat Bay via the Forked River and a man-made intake canal, and discharges heated water back to Barnegat Bay via a discharge canal and Oyster Creek. The current OL for OCNGS expires on April 9, 2009. By a letter dated July 22, 2005, AmerGen submitted an application (AmerGen 2005b) to the NRC to renew the OL for an additional 20 years of operation (i.e., until April 9, 2029). Details concerning the renewal of the OL can be found on the NRC website (NRC 2006a).

3.0 ENVIRONMENTAL SETTING

OCNGS is located in eastern New Jersey, approximately 60 mi south of Newark, 35 mi north of Atlantic City, and 50 mi east of Philadelphia, Pennsylvania (Figure 1). The nearest major water body is Barnegat Bay, a protected estuary on the central New Jersey coast (Figure 2). OCNGS is bounded on the north by the South Branch of the Forked River and on the south by Oyster Creek (Figure 3). Barnegat Bay is a shallow, lagoon-type estuary that is separated from the Atlantic Ocean by a nearly contiguous barrier island complex (Chizmadia et al. 1984; BBNEP 2001). The bay is approximately 43 mi long and 3 to 9 mi wide. Depths range from 3 to 23 ft, with the greatest depths associated with the Intracoastal Waterway, a dredged channel running parallel to the U.S. eastern seaboard (Chizmadia et al. 1984; BBNEP 2002). The total quantity of water associated with the bay is estimated to be 60 billion gal (Guo et al. 2004). The estuary is bordered by the mainland to the west, Point Pleasant and Bay Head to the north, the barrier islands to the east, and Manahawkin Causway to the south. Freshwater enters the bay from numerous streams, including, from north to south, Manasquan River and Canal, Metedeconk River, Kettle Creek, Toms River, Cedar Creek, Stout Creek, Forked River, and Oyster Creek (Chizmadia et al. 1984). Seawater enters the bay from the north through the Point Pleasant Canal via Manasquan Inlet and from the south through Little Egg Inlet. There is also an entrance to Barnegat Bay via Barnegat Inlet, a narrow navigable passage to the Atlantic Ocean through the barrier islands located to the southeast of Oyster Creek. The configuration of the Barnegat Inlet jetty system and the entrance channel have undergone extensive modifications by the U.S. Army Corps of Engineers, and a major

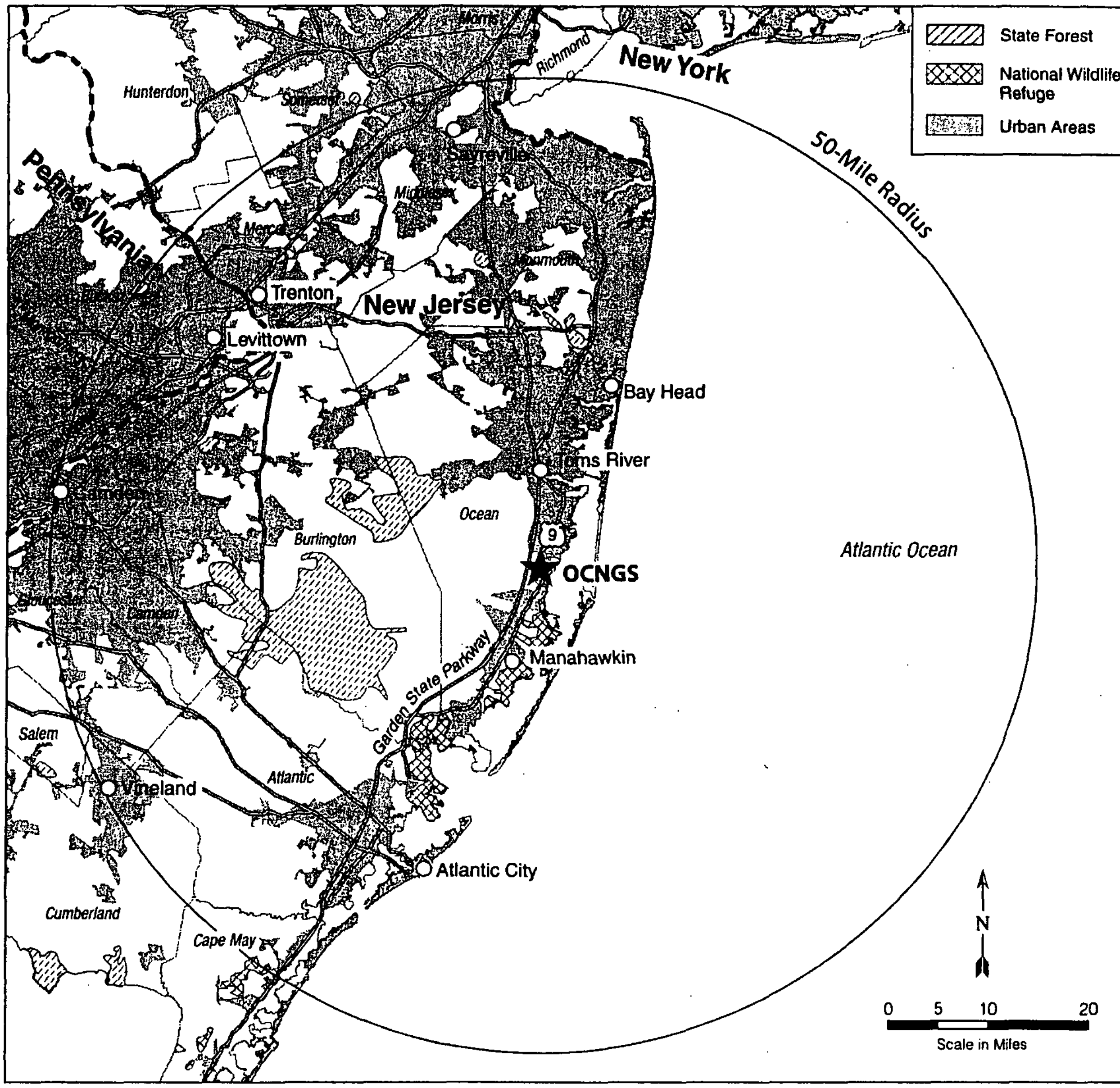

Figure 1. Location of Oyster Creek Nuclear Generating Station, 50-mi Region (Source: AmerGen 2005a)

program was initiated in 1988 to realign the south jetty and dredge accumulated sediments from the channel to improve navigation (Seabergh et al. 2003). Because of the limited connection of Barnegat Bay to the Atlantic Ocean, tides in the bay are attenuated relative to the open ocean. Complete turnover of the water within the bay is estimated to occur every 96 tidal cycles with 1 tidal cycle completed every 12.7 hr (Chizmadia et al. 1984;

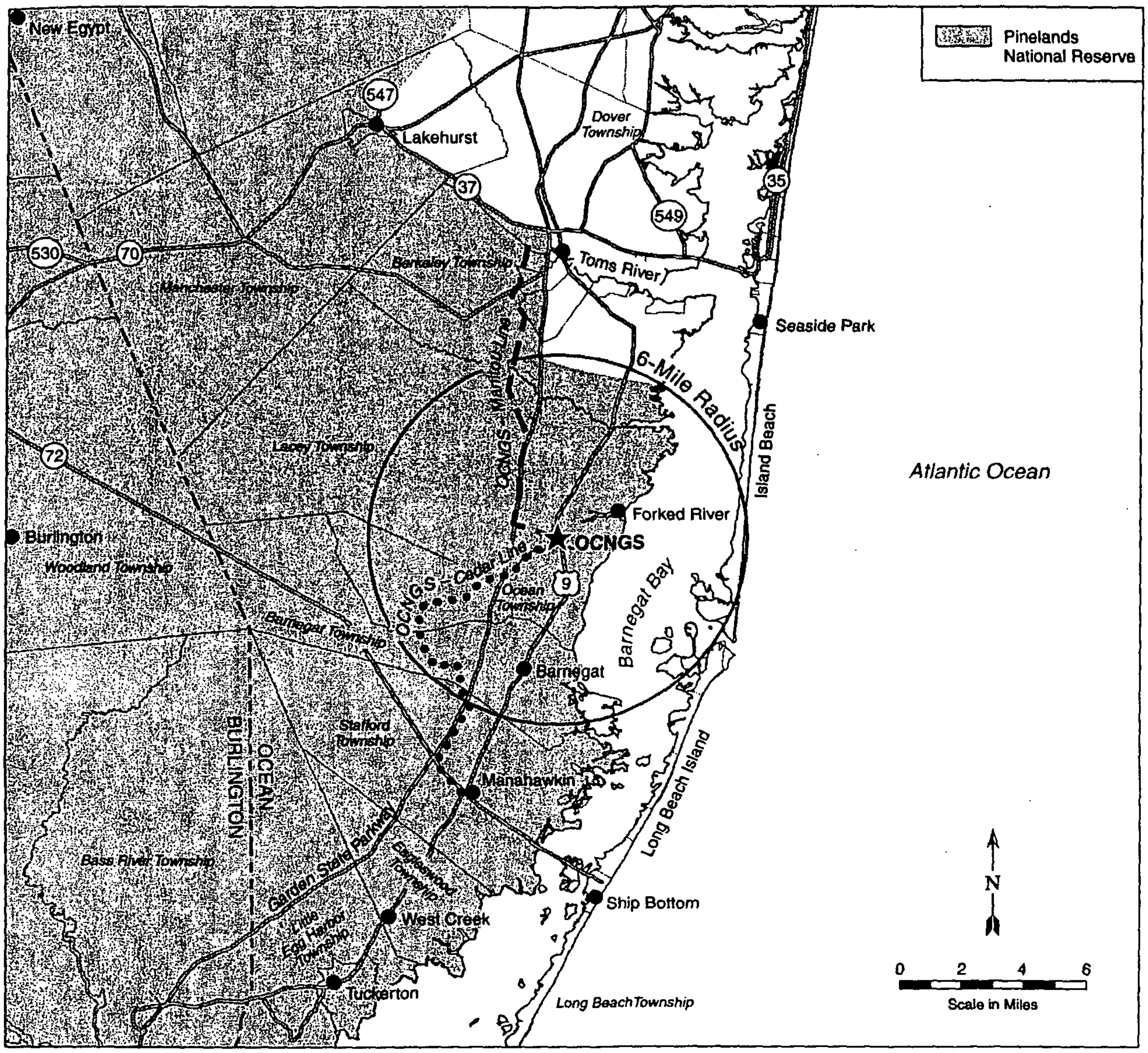

Figure 2. Location of Oyster Creek Nuclear Generating Station, 6-mi Region (Source: AmerGen 2005a)

Guo et al. 2004). Salinity ranges from approximately 11 to 32 parts per thousand (ppt); the highest salinity is associated with the inlets, and the lowest is along the western shoreline near the mouths of various rivers and creeks. Water temperature in Barnegat Bay ranges from an average of 34.9 °F (1.6 °C) in winter to 73.4 °F (23.0 °C) in summer (Chizmadia et al. 1984; BBNEP 2001).

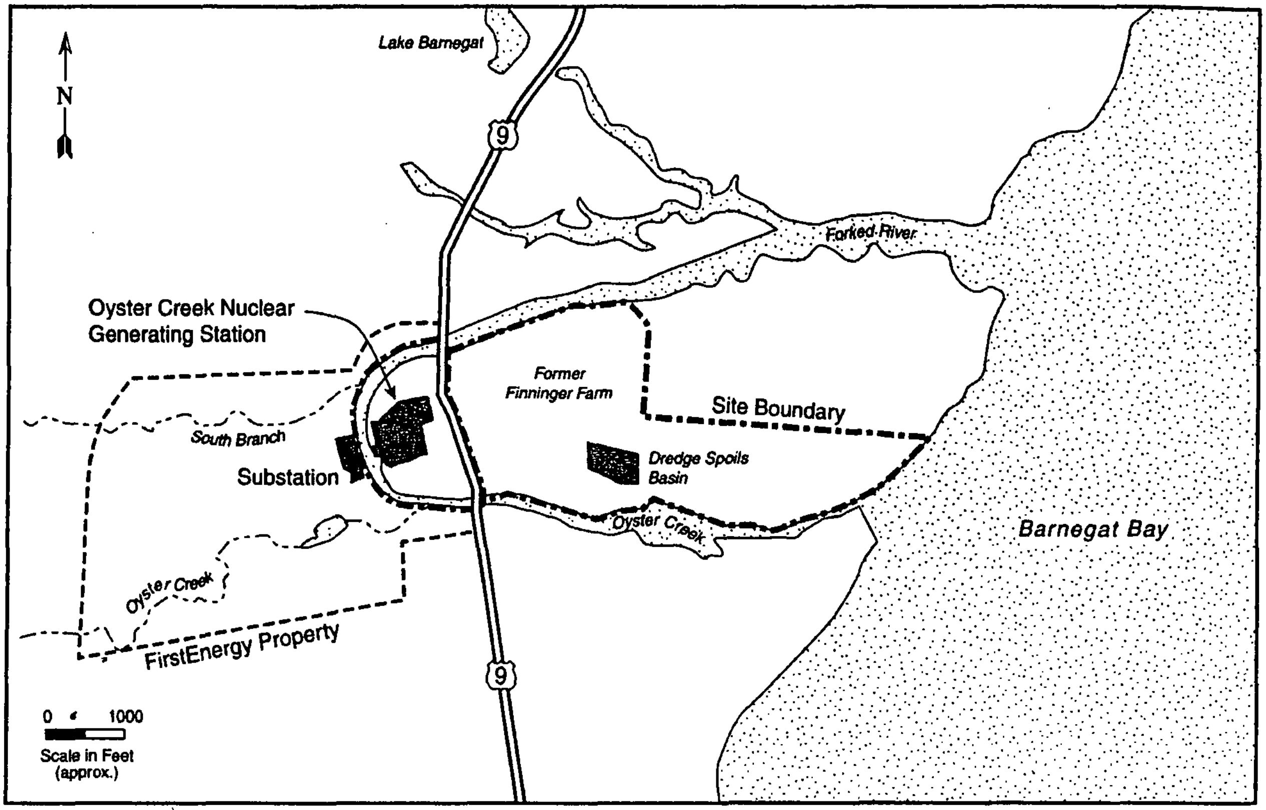

Figure 3. Oyster Creek Nuclear Generating Station Site Boundary (Source: AmerGen 2005a)

The substrate of Barnegat Bay is typical of a shallow estuary. Central portions of the bay are composed primarily of fine to medium sand, with muddier sand present closer to the western shore. The intertidal areas adjacent to the mouths of Forked River and Oyster Creek are primarily sandy mud (Chizmadia et al. 1984). The barrier islands and mainland shores of Barnegat Bay support a network of salt marshes and other coastal wetlands that represent important habitats for juvenile fish and invertebrates (BBNEP 2001). In recent years, concern has been raised regarding the loss of salt marsh habitat along the Atlantic Coast (GLCF 2005). The cause of the observed losses is not known, but it is assumed to be a combination of sea level rise and hydrologic changes that result in an inadequate supply of sediment required for marsh maintenance (Hartig and Gornitz 2001).

4.0 PLANT COOLING-WATER SYSTEM DESCRIPTION

OCNGS has a once-through cooling system that uses water from Barnegat Bay. Cooling water is withdrawn from the bay via the South Branch of the Forked River, then through a 150-ft-wide

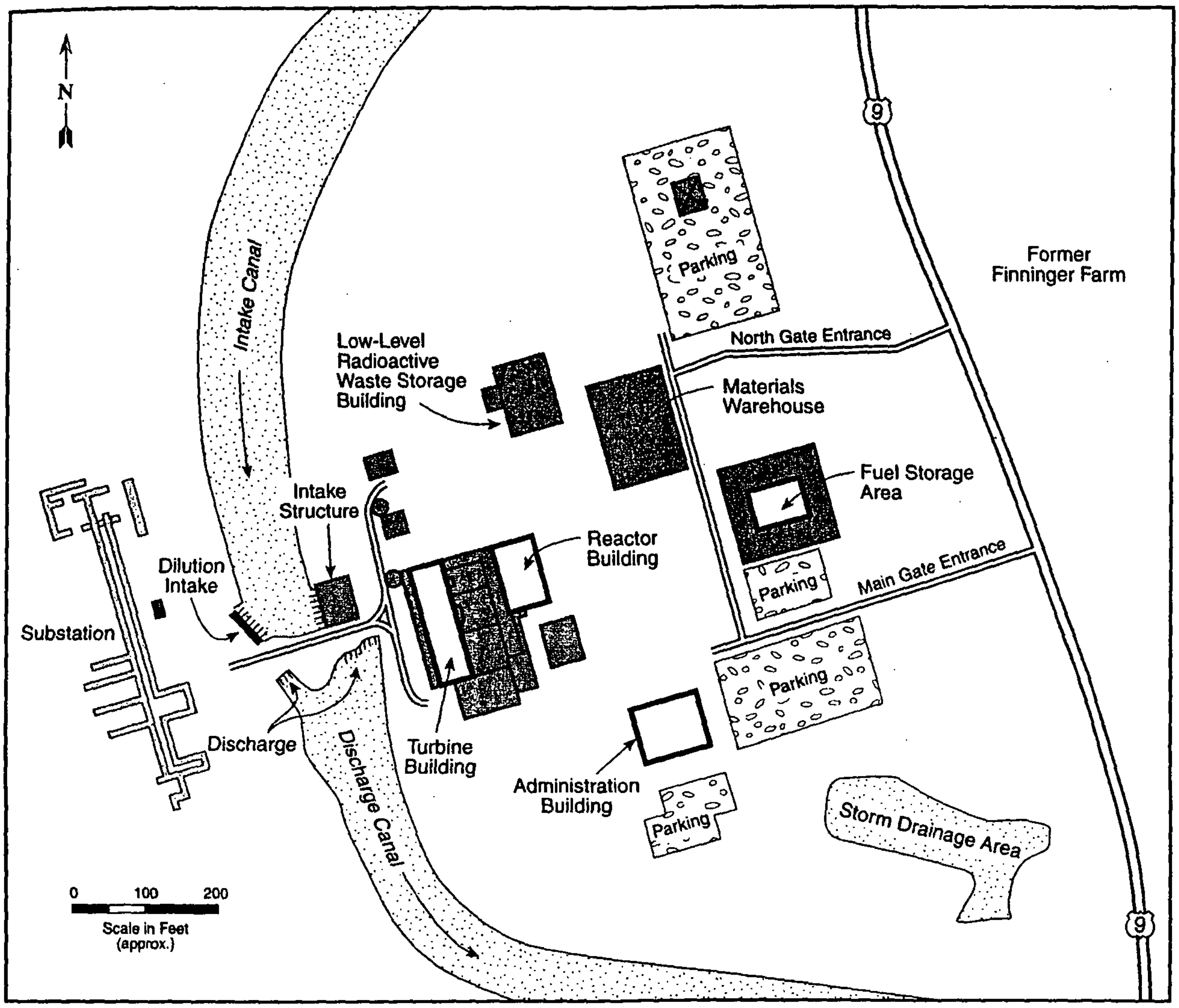

Figure 4. Oyster Creek Nuclear Generating Station Site Layout (Source: AmerGen 2005a)

intake canal to the intake structure. Heated cooling water is discharged to a 150-ft-wide discharge canal that flows into Oyster Creek, which in turn flows into the bay. The intake and discharge canals are divided by a berm. Three dilution pumps move water from the intake canal directly into the discharge canal to lower the temperature of the station cooling water in the discharge canal. Details on the circulating-water system are presented below. Unless otherwise noted, the discussion of the circulating-water system was obtained from the Updated Final Safety Analysis Report (AmerGen 2003), the Final Environmental Statement for OCNGS operations (AEC 1974), or the ER (AmerGen 2005a).

The intake structure has two bays, each equipped with a trash rack, a 3/8-in.-mesh traveling screen, a screen-wash system, two service-water pumps, two emergency service-water pumps, and two circulating-water pumps. Each of the four circulating-water pumps located in the intake structure can provide up to 115,000 gallons per minute (gpm) of cooling water to the condensers. In addition to the circulating water system OCNGS has a separate service water system that provides cooling water to the reactor building and turbine building heat exchangers. An angled boom in the intake canal immediately in front of the intake prevents large mats of eelgrass and algae from clogging the intake system.

The trash racks are composed of nearly vertical steel bars on 3-in. centers, with effective openings of 2.5 in. After passing through the trash racks, water passes through 3/8-in.-mesh traveling screens equipped with Ristroph buckets. A low-pressure screen wash washes off impinged aquatic organisms and debris into the Ristroph buckets. The Ristroph buckets empty into a flume that conveys the fish and shellfish to the head of the discharge canal in the area of the dilution pump discharge (NJDEP 2005a).

Each bay of the intake structure has a service-water pump with a capacity of 6000 gpm, a second service-water pump with a capacity of 2000 gpm, two emergency service-water pumps each with a capacity of 4150 gpm, and a screen-wash pump with a capacity of 900 gpm. These pumps are located immediately downstream of the traveling screens. Service water provides cooling water to the reactor building and turbine building heat exchangers. The service water empties into the discharge canal.

Three dilution water pumps (low-speed, axial flow pumps with 7-ft impellers, each rated at 260,000 gpm) are located on the western side of the intake canal and are protected by trash racks. Because the dilution pump intakes lack traveling screens, fish may be drawn through the pumps. No impingement or entrainment safeguards are present; however, AmerGen contends that the pump design allows for some impingement and entrainment survivability (NJDEP 2005a). The purpose of the dilution pumps is to decrease the temperature of the discharge water, which otherwise would encourage migratory fish to stay during the spring and fall, and to reduce thermal stress on organisms in the discharge canal during the summer. The use of the dilution pumps is covered in the New Jersey Pollutant Discharge Elimination System (NJPDES) permit, which allows only two of the three pumps to operate concurrently during normal operations. During a station shutdown, dilution pumps are operated to minimize the impact of thermal shock on organisms in Oyster Creek and Barnegat Bay. In the winter, a recirculation tunnel transfers water from the discharge to the intake structure as needed to prevent icing.

Sodium hypochlorite is injected into the circulating-water and plant service-water systems, and chlorine gas is injected into the augmented off-gas/new radioactive waste service-water system to minimize fouling in the pipes and condensers. The main condenser's six sections are chlorinated one at a time so that the sections are consecutively chlorinated for 20 minutes each during the daily cycle for a maximum of 2 hours per day of chlorination for the entire condensor (NJDEP 2005a).

5.0 POTENTIAL IMPACTS OF PLANT OPERATION ON BIOTA AND HABITAT

The cooling-water system associated with OCNGS utilizes water from Forked River and Barnegat Bay and may affect EFH in the following ways:

- Impingement of juvenile or adult forms of fish and shellfish;
- Entrainment of eggs or larvae of fish and shellfish, or of phytoplankton and zooplankton that form the basis of the nearshore marine food webs; and
- Discharge of heated cooling water containing biocides or other chemicals into Oyster Creek and Barnegat Bay

These impacts are discussed in this section.

5.1 IMPINGEMENT

At maximum flow, with all circulating and dilution pumps operating, the OCNGS cooling-water system requires approximately 1.25 million gpm. However, the licensee normally does not operate more than two dilution pumps at a time so total plant flow is typically less than one million gpm. At this flow rate, the velocity in the intake and discharge canals is typically less than 2.0 ft/s, but the flow is sufficient to result in impingement of fish and shellfish on the traveling screens associated with the cooling-water intake system.

Impingement mortality studies were conducted between 1965 and 1977 on a variety of fish and shellfish species, including bay anchovy (*Anchoa mitchilli*), Atlantic silverside (*Menidia menidia*), winter flounder (*Pseudopleuronectes americanus*), Atlantic menhaden (*Brevoortia tyrannus*), sand shrimp (*Crangon septemspinosa*), and blue crab (*Callinectes sapidus*). Winter flounder exhibited the highest survival after impingement (77 to 93 percent), and bay anchovy exhibited the lowest survival (4 to 19 percent) (Summers et al. 1989).

5.2 ENTRAINMENT

During normal operations, a variety of organisms are entrained, including eggs and larvae of fish and shellfish occurring in Barnegat Bay or Forked River, and phytoplankton and zooplankton that contribute to the marine-estuarine food web in Barnegat Bay. The number and variety of entrained organisms vary seasonally and annually. The most commonly entrained organisms include juvenile and adult opossum shrimp (*Neomysis integer*); zoea, juvenile, and adult sand shrimp; eggs and larvae of the bay anchovy; and larvae of winter flounder.

5.3 THERMAL RELEASES

The discharge of heated water into Oyster Creek creates elevated temperatures (>86 °F [30 °C]) in the discharge canal and produces a thermal plume in Barnegat Bay that varies in extent and magnitude based on plant operation characteristics, ambient air and water temperatures, and hydrodynamic characteristics associated with wind and tide. These thermal emissions have the potential to affect food web dynamics, alter fish behavior, or produce acute or chronic impacts on temperature-sensitive species.

The NJDEP fact sheet (NJDEP 2005a) identified the following thermal surface-water quality standards applicable to OCNGS operations:

- Ambient water temperatures in the receiving waters shall not be raised by more than 4 °F (2.2 °C) from June through August, nor more than 1.5°F (0.8°C) from June through August, nor cause temperature to exceed 85°F (29.4°C), except in designated heat dissipation areas.

- Heat dissipation in streams (including saline estuarine waters) shall not exceed one-quarter of the cross section and/or volume of the water body at any time; nor more than two-thirds of the surface from shore to shore at any time.

Interruption of the flow of heated water from the plant, or failure of the dilution pump system, has resulted in a number of fish kills since OCNGS began operating in 1969. Fish kills associated with thermal fluctuations from 1972 to 1982 are summarized in Kennish (2001). Additional details on fish kills related to thermal fluctuations at OCNGS are provided in Section 4 of Supplement 28 to the GEIS (NRC 2006b).

6.0 POTENTIAL EFFECTS OF THE PROPOSED ACTION ON DESIGNATED ESSENTIAL FISH HABITAT OF MANAGED SPECIES

6.1 EVALUATION OF SPECIES REQUIRING EFH CONSULTATION

During the development of this EFH assessment, NMFS websites (NMFS 2006a,b,c) were consulted to develop an initial list of candidate fish species that would be considered for EFH consultation. Because Barnegat Bay encompasses four different 10-minute × 10-minute grids for EFH habitats in addition to the Barnegat Bay complex (Table 1), the initial candidate species list includes organisms living in nearshore estuarine and oceanic habitats (Table 2). During the initial review of life history and EFH requirements for each candidate species, some species or life stages were eliminated from further consideration based on salinity or depth requirements, or life history information that suggested that the appearance of some species or life stage is unlikely in Barnegat Bay, Oyster Creek, or Forked River (Table 3). Table 4 gives the final list of species and life stages that were evaluated in this EFH assessment.

Table 1. Essential Fish Habitat Areas Associated with Barnegat Bay

North	East	South	West	Web Address
40° 10.0'N	74° 0.00'W	40° 00.0'N	74° 10.0'W	http://www.nero.noaa.gov/hcd/STATES4/new_jersey/40007400.html
40° 00.0'N	74° 0.00'W	39° 50.0'N	74° 10.0'W	http://www.nero.noaa.gov/hcd/STATES4/new_jersey/39507400.html
39° 50.0'N	74° 10.0'W	39° 40.0'N	74° 20.0'W	http://www.nero.noaa.gov/hcd/STATES4/new_jersey/39407400.html
39° 40.0'N	74° 10.0'W	39° 30.0'N	74° 20.0'W	http://www.nero.noaa.gov/hcd/STATES4/new_jersey/39307410.html
Barnegat Bay, New Jersey				http://www.nero.noaa.gov/hcd/nj1.html

6.2 SPECIES DESCRIPTIONS AND IMPACT DETERMINATION

EFH requirements for the relevant species and life stages presented in Table 4 are discussed in this section. Species descriptions include, if available, information on fish abundance patterns in Barnegat Bay, common depth distributions, migratory and spawning habits, tolerance and preference ranges for temperature and salinity, habitat needs, and information on food preferences. For each species and life stage, OCNGS operations were evaluated to determine whether they resulted in (1) no adverse impact, (2) minimal adverse impact, or (3) substantial adverse impact on EFH. These impact categories follow the standard used by

Table 2. Initial List of Candidate Species and Life Stages Considered for Inclusion in EFH Assessment

		Life Stage				
Scientific Name	**Common Name**	**Egg**	**Larvae**	**Juvenile**	**Adult**	**Spawning Adult**
Carcharhinus obscurus	dusky shark		◆[(a)]			
Carcharhinus plumbeus	sandbar shark		◆[(a)]	◆	◆	
Centropristis striata	black sea bass			◆	◆	
Clupea harengus harengus	Atlantic sea herring			◆	◆	
Gadus morhua	Atlantic cod				◆	
Galeocerdo cuvier	tiger shark		◆[(a)]	◆		
Glyptocephalus cynoglossus	witch flounder	◆				
Hippoglossoides platessoides	American plaice			◆	◆	
Leocoraja erinacea	little skate			◆	◆	
Leucoraja ocellata	winter skate			◆	◆	
Limanda ferruginea	yellowtail flounder	◆	◆			
Lophius americanus	monkfish	◆	◆			
Merluccius bilinearis	whiting	◆	◆	◆	◆	
Paralichthys dentatus	summer flounder		◆	◆	◆	
Peprilus triacanthus	Atlantic butterfish			◆		
Pomatomus saltatrix	bluefish			◆	◆	
Pseudopleuronectes americanus	winter flounder	◆	◆	◆	◆	◆
Rachycentron canadum	cobia	◆	◆	◆	◆	
Raja eglanteria	clearnose skate			◆	◆	
Scomberomorus cavalla	king mackerel	◆	◆	◆	◆	
Scomberomorus maculatus	Spanish mackerel	◆	◆	◆	◆	
Scophthalmus aquosus	windowpane flounder	◆	◆	◆	◆	◆
Spisula solidissima	surf clam			◆	◆	
Stenotomus chrysops	scup			◆	◆	
Urophycis chuss	red hake	◆	◆	◆		
Zoarces americanus	ocean pout	◆		◆	◆	

(a) Neonates and/or early-stage juveniles.

Table 3. Species and Life Stages Eliminated from Consideration in EFH Assessment and Rationale for Elimination

Common Name	Life Stages Eliminated from EFH Assessment	Rationale for Elimination
American plaice	All life stages	Salinity and depth requirements not present in Barnegat Bay
Atlantic butterfish	All life stages	Depth requirements not present in Barnegat Bay
Atlantic cod	All life stages	Salinity and depth requirements not present in Barnegat Bay
Atlantic sea herring	All life stages	Salinity and depth requirements not present in Barnegat Bay
Black sea bass	Adults (juveniles retained)	Depth requirements not present in Barnegat Bay
Bluefish	Adults (juveniles retained)	Salinity requirements not present in Barnegat Bay
Cobia	All life stages	Salinity requirements not present in Barnegat Bay
King mackerel	All life stages	Salinity requirements not present in Barnegat Bay
Monkfish	All life stages	Depth requirements not present in Barnegat Bay
Ocean pout	All life stages	Salinity requirements not present in Barnegat Bay
Red hake	Juveniles (eggs and larvae retained)	Salinity requirements not present in Barnegat Bay
Spanish mackerel	All life stages	Salinity requirements not present in Barnegat Bay
Summer flounder	Larvae (juveniles and adults retained)	Depth requirements not present in Barnegat Bay
Whiting	All life stages	Depth requirements not present in Barnegat Bay
Witch flounder	All life stages	Salinity and depth requirements not present in Barnegat Bay
Yellowtail flounder	All life stages	Salinity and depth requirements not present in Barnegat Bay

Table 4. Species and Life Stages Included in EFH Consultation

Common Name	Egg	Larvae	Juvenile	Adult	Spawning Adult
Black sea bass			◆		
Bluefish			◆		
Clearnose skate			◆	◆	
Dusky shark		◆[a]			
Little skate			◆	◆	
Red hake	◆	◆			
Sandbar shark		◆[a]	◆	◆	
Scup			◆	◆	
Summer flounder			◆	◆	
Surf clam			◆	◆	
Tiger shark		◆[a]	◆		
Windowpane flounder	◆	◆	◆	◆	◆
Winter flounder	◆	◆	◆	◆	◆
Winter skate			◆	◆	

Life Stage columns: Egg, Larvae, Juvenile, Adult, Spawning Adult.

(a) Neonates and/or early-stage juveniles.

the Northeast Regional Office of the NMFS. To determine impact level, OCNGS monitoring data, scientific journal articles or technical reports, and other relevant information were reviewed.

Black Sea Bass (*Centropristis striata*)

Barnegat Bay is considered EFH for juvenile black sea bass. The shallow depth of Barnegat Bay prevents it from meeting EFH criteria for black sea bass adults. Juveniles enter the estuary in late spring and early summer after settlement has occurred in coastal waters, and move to warmer offshore or southern waters during the winter months. Juvenile young-of-the-year (YOY) are tolerant of temperatures of 43-86 °F (6 to 30 °C) and salinities of 8 to 38 ppt, but prefer temperatures of 63-77 °F (17 to 25 °C) and salinities of 18 to 20 ppt. In winter, juvenile black sea bass require water temperatures higher than 41 °F (5 °C) and prefer salinities of approximately 18 to 20 ppt (NMFS 1999a). The EFH of juvenile black sea bass includes shallow, hard-bottom substrates with structure present to provide protection and refuge. Suitable habitat includes oyster or mussel beds, seagrass beds, piers, wharves,

artificial reefs, and cobble and shoal areas (NMFS 2006a,b,c). Juveniles do not prefer open areas, unvegetated sandy intertidal areas, or beaches. Juvenile black sea bass are diurnal, visual predators, and their diet consists of small benthic crustaceans, polychaetes, sand shrimp, amphipods, and shrimp. There is also no evidence that entrainment of prey items (e.g., sand shrimp) has significantly disrupted the population of juvenile black sea bass in Barnegat Bay. Reported losses of seagrass habitat in Barnegat Bay appear to be related to increased urbanization and possibly to alterations to Barnegat Inlet that have changed the salinity and resulted in the proliferation of algal blooms that can kill seagrass or limit light penetration and productivity (McLain and McHale 1996; BBNEP 2001; Gastrich et al. 2004). This species is not commonly impinged on OCNGS traveling screens, nor has it been identified in episodic fish kills associated with the thermal plume. Although prey items are entrained or impinged in the OCNGS cooling system, there is no indication that prey populations have been measurably affected. OCNGS operations would likely have a minimal adverse effect on juvenile black sea bass EFH.

Bluefish (*Pomatomus saltatrix*)

Barnegat Bay is considered EFH for juvenile and adult bluefish, although adults are generally not found in the bay because they require oceanic (>35 ppt) salinity. According to the NMFS (1999b), juvenile bluefish distribution over the continental shelf has not been documented; thus, it is unclear whether this life stage is estuarine-dependent. Juveniles have been observed in all estuaries within the Middle Atlantic Bight from May through October. As water temperatures cool during the autumn and winter, juveniles and adults move south. Optimum conditions for pelagic juveniles (summer cohort) include temperatures of 59 to 68 °F (15 to 20 °C) and salinities of 31 to 36 ppt. Summer cohort juveniles prefer temperatures of 68 to 86 ° F (20 to 30 °C) and salinities of 23 to 33 ppt. Bluefish are known to be voracious predators and appear to eat whatever prey items are abundant, including small fish, polychaetes, and crustaceans. It is likely that the juvenile summer-spawned cohort uses Barnegat Bay as a nursery area (Tatham et al. 1984). Although juvenile bluefish are among the species that have been killed by thermal shock associated with OCNGS operations (Kennish 2001), the number of fish kills has declined dramatically over the past decade because of improved procedures. There is no evidence that large numbers of juvenile bluefish are impinged on the OCNGS cooling system traveling screens, nor is there evidence that entrainment or impingement of prey items at OCNGS has resulted in a detectable disruption of the food web in Barnegat Bay (EA 1986; Summers et al. 1989). It appears that OCNGS operations would likely have a minimal adverse effect on bluefish EFH.

Clearnose Skate (*Raja eglanteria*)

On the basis of the distribution patterns described by NMFS (2006c), Barnegat Bay may provide EFH for juvenile and adult clearnose skates. Little information is available to determine

whether juveniles and adults frequent Barnegat Bay. However, there is some evidence that they enter the coastal waters of New Jersey during the spring and early summer and move offshore and southward as the water cools during the autumn and winter (NMFS 2003a). Tatham et al. (1984) considered the clearnose skate as a local marine stray in Barnegat Bay. Clearnose skates occur over a relatively large temperature range (48 to 86 °F [9 to 30 °C]) and have been found in water with salinity ranging from 6 to greater than 35 ppt (NMFS 2003a). The optimum temperature for both juveniles and adults appears to be approximately 48 to 68°F (9 to 20 °C), and the optimum salinity appears to range from 31 and 35 ppt. Skates are often found on soft-bottom habitats along the continental shelf and have been caught in water depths ranging from approximately 1 to 300 m; they are most common in waters ranging from about 5 to 20 m. Juveniles and adults generally move inshore and northward during the spring and early summer, and offshore and southward during the autumn and early winter. Juvenile and adult clearnose skates are not commonly impinged on the OCNGS traveling screens, nor is there evidence to suggest that clearnose skates make significant use of the estuary for reproduction or nursery activities. It is also unlikely that OCNGS operations have adversely affected EFH for this species because the operational impacts on nearshore sediments are generally restricted to Oyster Creek and Forked River (EA 1986; Summers et al. 1989). Although prey items are entrained or impinged in the OCNGS cooling system, there is no indication that prey populations have been measurably affected. OCNGS operations would likely have a minimal adverse effect on EFH for adult or juvenile clearnose skates.

Dusky Shark (*Carcharhinus obscurus*)

According to the NMFS (2006c), Barnegat Bay is designated as EFH for dusky shark neonates and early-stage juveniles. Shallow bays and estuaries are used as nursery areas for young sharks. After giving birth, females leave the estuary (FMNH 2006a). Adults are considered highly migratory (NMFS 2006d) and generally move north during the summer and south during the winter. Adults avoid low-salinity conditions and rarely enter estuaries. This species was not identified in Barnegat Bay by Tatham et al. (1984). EFH for neonates and early-stage juveniles is considered to be shallow coastal waters, inlets, and estuaries to depths of approximately 25 m (NMFS 2006d), and it appears that the young sharks are tolerant of both temperature and salinity extremes common to estuaries. Because recently born sharks are approximately one m in length, their diet is assumed to be similar to adults and includes a variety of fish and invertebrates occurring near the bottom. This species was not commonly impinged (EA 1986; Summers et al. 1989), and dusky sharks have not been found in OCNGS fish kills. Although prey items are entrained or impinged in the OCNGS cooling system, there is no indication that prey populations have been measurably affected. OCNGS operations would likely have a minimal adverse effect on EFH for neonates and early-stage juveniles.

Little Skate (*Leocoraja erinacea*)

On the basis of the distribution patterns presented in NMFS 2006c, Barnegat Bay likely contains EFH for juvenile and possibly adult little skates. Adults and juveniles generally move into shallow coastal areas and estuaries during the spring and summer, and into deeper water during the winter. They may also leave estuaries for deeper waters during warm summer months (NMFS 2003b). Juvenile skates are generally found in water depths ranging from 1 to 400 m, but are most common in depths of 5 to 8 m. They are able to tolerate temperatures ranging from 32 to 45 °F (0 to 7 °C) in the winter and 57 to 72 °F (14 to 22 °C) in the summer, and salinity ranging from approximately 15 to 35 ppt. Adults and juveniles collected from the New York Bight were found at a mean temperature of 47 °F (8.5 °C) and a mean salinity of 32 ppt (NMFS 2003b). Preferred prey items for adult and juvenile little skates include decapod crustaceans and amphipods. Fish and squid are also eaten. On the basis of studies of the OCNGS once-through cooling system, entrainment of early life stages of fish and invertebrates has not adversely affected the prey items of Barnegat Bay that could potentially support juvenile and adult skates, nor is this species commonly impinged on the traveling screens associated with the cooling-water intakes. Although fish kills due to thermal fluctuations have occurred, little skate was not among the species killed. OCNGS operations would likely have a minimal adverse effect on EFH for juvenile and adult little skate.

Red Hake (*Urophycis chuss*)

Barnegat Bay is considered EFH for eggs and larvae of the red hake. Red hake are demersal fish common along the New Jersey coastline. Spawning adults are known to frequent coastal ports, and spawning occurs from about April to November at temperatures between 41 and 50 ° F (5 and 10 °C) (NMFS 1999c). Eggs are about 0.6 to 1.0 mm in diameter and float near the water surface. EFH for red hake eggs includes surface waters of the middle Atlantic region at sea surface temperatures below 50 °F (10 °C) and salinities of less than 25 ppt. Eggs are usually observed from May to November, with peak densities during June and July (NMFS 2006a,c). Temperature dependent hatching occurs at temperatures ranging from 37 to 45 °F (3 to 7 °C). Larvae of red hake are less than 2.0 mm at hatching and dominate the ichthyoplankton during the late summer months in the Middle Atlantic Bight (NMFS 1999c). EFH for larval red hake includes surface waters of the middle Atlantic region at depths less than 200 m, temperatures less than 66 °F(19 °C), and salinities greater than 0.5 ppt. Larvae are observed from May to December, with peak densities in September and October (NMFS 2006b). Larvae are nocturnal feeders that prey upon copepods and other microcrustaceans. On the basis of results of the 316(b) demonstration study at OCNGS (EA 1986; Summers et al. 1989), eggs and larvae of red hake were not identified in entrainment samples at OCNGS, nor is there evidence that entrainment or thermal fluctuations associated with the facility have resulted in a detectable disruption of food web dynamics in the estuary with respect to the

presence and abundance of microcrustacean prey items. OCNGS operations would likely have a minimal adverse effect on EFH for red hake eggs and larvae.

Sandbar Shark (*Carcharhinus plumbeus*)

Barnegat Bay is considered EFH for neonate, juvenile, and adult sandbar sharks. Sandbar sharks are bottom-dwelling and represent one of the most numerous shark species in the western Atlantic. EFH requirements for neonates and early juveniles (90 cm or less) include shallow coastal waters at depths reaching 25 m, and nursery areas generally located in shallow coastal waters with temperatures higher than 70 °F (21 °C) and salinities greater than 22 ppt (NMFS 2006b). EFH for late-stage juveniles and subadults (91 to 179 cm) is identified in coastal and pelagic waters near Barnegat Inlet that range in depth from 25 to 200 m (NMFS 2006c). EFH for adult sandbar sharks (>179 cm) includes shallow coastal areas to a depth of 50 m. Temperature and salinity preferences for various life stages are assumed to be typical of estuaries. Sandbar sharks are opportunistic feeders, and prey items commonly include small fish, molluscs, and crustaceans. Some of these prey are commonly impinged at OCNGS. The sandbar shark was not identified as a common species in Barnegat Bay by Tatham et al. (1984), juveniles and adults are not routinely impinged on the OCNGS traveling screens (EA 1986; Summers et al. 1989), and this species has not been found in OCNGS fish kills (Kennish 2001). OCNGS operations would likely have a minimal adverse effect on EFH for this species.

Scup (*Stenotomus chrysops*)

Barnegat Bay contains EFH for the both juvenile and adult scup. Scup are considered a temperate species, with a range extending from Massachusetts to South Carolina, and are common in the summer and early fall in coastal estuaries containing both open and structured environments (NMFS 1999d). Tatham et al. (1984) considered scup a local marine stray in Barnegat Bay. Juveniles are found in water depths ranging from intertidal to approximately 39 m; they prefer water temperatures of approximately 61 to 70 °F (16 to 22 °C), but are found in water with temperatures higher than 45 °F (7 °C) in winter. Juveniles in estuaries are found at salinities greater than 15 ppt; those in coastal environments are found at salinities exceeding 30 ppt. The primary prey items for juveniles include small benthic invertebrates, fish eggs, and larvae. EFH for juvenile scup includes the demersal waters over the continental shelf and estuaries where juvenile scup are abundant. In estuaries like Barnegat Bay, juveniles are commonly found in sandy and muddy environments, near mussel and eelgrass beds where water temperatures are higher than 45 °F (7 °C) and salinities are greater than 15 ppt. In summer, adult scup are found in water depths of approximately 2 to 38 m, at temperatures ranging from 45 to 77 °F (7 to 25 °C), and at salinities greater than 15 ppt. In winter, adults are generally found offshore in water depths ranging from 38 to 185 m, water temperatures higher than 45 °F (7 °C), and salinities exceeding 30 ppt (NMFS 2006b). Adult scup feed on small

benthic invertebrates and small fish. EFH for adult scup is similar to that described for juveniles. Fish kills at OCNGS have included scup, but fewer than 10 individuals were killed per event. Previous studies and the conclusions of Kennish (2001) indicate that there is no evidence that OCNGS operations have resulted in detectable changes in scup prey populations. On the basis of work by Tatham et al. (1984), scup were not abundant in Barnegat Bay during the 1980s, nor were they commonly entrained at OCNGS (EA 1986; Summers et al. 1989). OCNGS operations would likely have a minimal adverse effect on EFH for scup juveniles and adults.

Summer Flounder (*Paralichthys dentatus*)

Barnegat Bay is considered EFH for summer flounder juveniles and adults. 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 1999e). Tatham et al. (1984) considered this species a warmwater migrant in Barnegat Bay. 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. EFH for juveniles includes demersal waters over the continental shelf, and estuaries where juveniles have been observed. Nursery habitat used by juvenile flounder in Barnegat Bay includes salt marsh creeks, seagrass beds, mudflats, and open bay areas. Preferred water temperature is higher than 37 °F (3 °C), and preferred salinities range from 10 to 30 ppt. EFH for adult summer flounder includes demersal waters over the continental shelf at water depths to 152 m and coastal systems similar to Barnegat Bay (NMFS 2006c). 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 OCNGS operations on summer flounder EFH are expected to be impingement of juveniles and adults on OCNGS traveling screens, and impacts associated with the OCNGS thermal discharges. Annual summer flounder impingements ranged from 1308 to 4266 individuals. This represented less than 0.2 percent of the total number of individual fish impinged during that period and was considered inconsequential by EA (1986), given the number of fish caught by recreational anglers during that period. Fish kills associated with thermal fluctuations at OCNGS did not include summer flounder (Kennish 2001). Also, there is no evidence to suggest that the operation of the facility has significantly affected the prey of this species (EA 1986; Summers et al. 1998). Thus, OCNGS operations would likely have a minimal adverse effect on EFH for this species.

Surf Clam (*Spisula solidissima*)

The coastal region adjacent to Barnegat Bay is considered EFH for juvenile and adult surf clams. Both adults and juveniles are found along the Atlantic Coast from the Gulf of St. Lawrence to Cape Hatteras, from the beach zone to a water depth of approximately 60 m

(FWS/DOI/USACE 1983; Weinberg 2000; NJDEP 2005b). The species prefers oceanic salinities (>32 ppt) and temperatures ranging from 59 to 86 °F (15 to 30 °C). Both juveniles and adults are filter-feeders, and their diet consists of a variety of algae associated with the sediment surface and the water column. EFH for juveniles and adults includes substrates to a depth of one m below the water-sediment interface in waters from the eastern edge of Georges Bank and the Gulf of Maine through the Atlantic Exclusive Economic Zone, in areas that encompass the top 90 percent of all ranked 10-minute squares for the areas where surf clams were caught during the Northeast Fisheries Science Center surf clam and ocean quahog dredge surveys (NMFS 2006c). Because surf clams are known to burrow in medium to coarse sand and gravel substrates, they may occur in Barnegat Bay near the Barnegat Inlet. It is unlikely that OCNGS operations impact the EFH or food supply of surf clams because they are generally found in coastal rather than estuarine waters. Surf clam larvae have not been reported in OCNGS entrainment samples, and hydrodynamic modeling indicates that the OCNGS thermal plume does not extend to Barnegat Inlet (EA 1986). Although the number of surf clams appears to have decreased since 1996, a variety of factors are likely responsible for the decline, including a change in ambient water temperature due to a warm water intrusion over the mid-Atlantic shelf. This intrusion may be responsible for the mortality of larger clams, and the gradual northward shift of the population (Weinberg 2000). In conclusion, no adverse effect on surf clam EFH is expected from continued OCNGS operations.

Tiger Shark (*Galeocerdo cuvier*)

Barnegat Bay is considered EFH for neonate and juvenile tiger sharks (NMFS 2006b). This species is common throughout the world in temperate waters and exhibits a high tolerance for many different kinds of marine habitats, including rivers, estuaries, harbors, and other nearshore locations where there are numerous prey items (FMNH 2006b). Adults migrate north from tropical to temperate waters during the summer months and return to the tropics during the winter. Mating occurs between March and May, and young are born between April and June of the following year. EFH for neonates and juveniles includes shallow coastal waters to a depth of 200 m from Cape Canaveral, Florida, to offshore Montauk, Long Island, New York (NMFS 2006c). Adults are known to feed on a variety of fish and invertebrates, and it is assumed that juveniles share this characteristic. Juveniles are not routinely impinged on the traveling screens associated with the circulating-water cooling system, nor is there evidence to suggest that plant operations have significantly affected prey populations (Kennish 2001). OCNGS operations would likely have a minimal adverse effect on EFH of the tiger shark.

Windowpane Flounder (*Scophthalmus aquosus*)

Barnegat Bay is considered EFH for all life stages of the windowpane flounder, including spawning adults (NMFS 2006b). This species occurs in estuaries, nearshore waters, and waters associated with the continental shelf along the Atlantic Coast from the Gulf of

St. Lawrence to Florida, and is most abundant in water depths of two m or less (NMFS 1999f). Eggs are buoyant and are typically found in surface waters, with greatest abundance between May and October. Larvae are approximately 2 mm long at hatching, and metamorphose into juvenile forms when they reach a length of approximately 5.5 mm; they settle to the bottom when they reach a total length of approximately 10 mm (Bigelow and Schroeder 1953). Juveniles typically reach a size range of 11 to 19 cm about 4 months after spawning, and the total length of adults is about 46 cm (NMFS 1999f). Adults generally spawn from February to December, with peak spawning occurring in May in the middle-Atlantic region (NMFS 2006a). Juvenile and adult windowpane flounder feed on small crustaceans (mysid shrimp and decapods) and larval forms of fish.

EFH for eggs includes surface waters extending from the Gulf of Maine to Cape Hatteras. Optimum water temperatures are less than 68 °F (20 °C) and water depths of less than 70 m (NMFS 2006c). EFH for larvae is similar to that described for eggs. EFH for juvenile windowpane flounder includes mud or fine-grained sand substrates with water temperatures below 77 °F (25 °C), depths of 1 to 100 m, and salinities between 5.5 and 36 ppt (NMFS 2006c). EFH for adults is similar to that described for juveniles, with water temperatures below 81 °F (27 °C). Spawning adults in the mid-Atlantic region prefer habitats with mud or fine-grained sand, water temperatures below 70 °F (21 °C), salinities ranging from 5.5 and 36 ppt, and water depths ranging from 1 to 75 m. The peak spawning period is May (NMFS 2006c).

Because all life stages of windowpane flounder could occur in Barnegat Bay, it is possible that OCNGS activities could adversely affect EFH for this species. Tatham et al. (1984) considered the windowpane flounder a local marine stray and did not consider it to be an abundant species based on trawl studies in the study area from 1975 to 1978, nor was it designated as a species that uses the estuary for spawning or as a nursery area. On the basis of commercial landing data for this species for the state of New Jersey provided by the NMFS (2005), commercial landings of windowpane flounder during the Tatham et al. study period ranged from 0 to 0.6 metric tons, and were less than 4.5 metric tons from 1971 to 1996. This could account for the low abundances of this species in Barnegat Bay. Commercial landings in New Jersey increased dramatically after 1996, peaking at 51 metric tons in 2001. Commercial landings of windowpane flounder have declined since 2001 and accounted for 16.9 metric tons in 2004 (NMFS 2005).

The results of studies conducted at OCNGS between 1965 and 1977 suggest that eggs and larvae of windowpane flounder are not commonly entrained, and there was no evidence of significant impingement of this species during that time (EA 1986; Summers et al. 1989). In addition, this species has not been found in fish kills resulting from OCNGS operations (Kennish 2001). Unfortunately, most of the relevant information collected to determine potential OCNGS impacts occurred during a period of low abundance of this species (NMFS 2005).

Detailed abundance, entrainment, and impingement data are not available for Barnegat Bay during years when commercial landings were at historical highs (1997 to 2004). Therefore, it is not possible to quantify EFH impacts for this species during that period. Despite this, it appears likely that the general conclusions stated in EA (1986), Summers et al. (1989), and Kennish (2001) are still valid. All three sources concluded that the operation of OCNGS did not result in a discernable effect on invertebrate or fish communities in Barnegat Bay. OCNGS operations are expected to result in a minimal adverse effect on EFH for windowpane flounder eggs, larvae, juveniles, adults, and spawning adults.

Winter Flounder (*Pseudopleuronectes americanus*)

Barnegat Bay is considered EFH for all lifestages of the winter flounder, including spawning adults. Winter flounder represent a valuable recreational and commercial resource along the Atlantic Coast; this species is ubiquitous in inshore areas from Massachusetts to New Jersey (NMFS 1999g). Winter flounder eggs are adhesive and occur in clusters. Larval forms are initially planktonic and begin to settle to the bottom when they reach a length of approximately 9 to 13 mm. In New Jersey waters, YOY and juvenile winter flounder are found in shallow water, where they may grow from 0.23 to 0.47 mm per day (NMFS 1999g). Adults can grow to a length of 58 cm and may live up to 15 years. Adults enter nearshore estuaries and rivers during the fall and early winter and spawn in late winter and early spring. After spawning, adults typically leave inshore areas. Winter flounder larvae eat small planktonic organisms (copepods, eggs, and phytoplankton); juveniles and adults are opportunistic feeders, and their diets include polychaetes and crustaceans. EFH for winter flounder eggs consists of bottom habitats with sand, muddy sand, and gravel substrates; a depth range of 0.3 to 4.5 m, an optimum temperature range of 37 to 41 °F (3 to 5 °C), and a preferred salinity range of 10 to 32 ppt (NMFS 1999g; NMFS 2006a). EFH for larvae includes shallow (1 to 4.5 m) inshore areas with a fine sand to gravel substrate, temperatures of 36 to 59 °F (2 to 15 °C), and a salinity range of 3.2 to 30 ppt. YOY and juveniles prefer a habitat consisting of mud or sand (with shell fragments) and water depths ranging from approximately 0.5 to 27 m. Preferred temperatures range from 36 to 84 °F (2 to 29 °C) for YOY and from 50 to 77 °F (10 to 25 °C) for juveniles. Preferred salinity ranges are approximately 23 to 33 ppt for YOY and 19 to 21 ppt for juveniles. Adult winter flounder are typically found in 1 to 30 m of water with a mud, sand, or large cobble substrate. The preferred water temperature range is 54 to 59 ° F (12 to 15 °C), and the preferred salinity range is 15 to 33 ppt.

OCNGS operations have the potential to adversely affect EFH for all life stages of winter flounder because all stages could occur in Barnegat Bay. Tatham et al. (1984) considered the winter flounder a resident species in Barnegat Bay that made significant use of the estuary for spawning and as a nursery area; the years of study (1975 to 1978) reflected a period when commercial landings in New Jersey waters ranged from 47.7 to 92.7 metric tons. These data appear to reflect a low point in the population based on data from 1979 to 2004, when catches

usually exceeded 100 metric tons and were greater than 200 metric tons for seven years during that period (NMFS 2005). Winter flounder larvae represented between 1 and 10 percent of the annual OCNGS entrainment measured in studies from 1975 to 1981 (Summers et al. 1989). Juvenile and adult opossum shrimp represented the largest percentage of organisms entrained during that period (49 to 91 percent). The total number of entrainment losses for winter flounder larvae for 1975 to 1976, 1977 to 1978, and 1980 to 1981 was 4330 million organisms (Summers et al. 1989). Opossum shrimp entrainment losses during this same period were 209,889 million organisms (Summers et al. 1989). Winter flounder are also impinged on the OCNGS traveling screens. Annual impingement of winter flounder from 1975 to 1985 ranged from 8908 individuals in 1975 to 1976, to more than 148,000 individuals from 1978 to 1979), and the average annual impingement was estimated (EA 1986) to be 38,866 individuals during that period. These totals represented less than 1.5 percent of the total impingements observed at the facility during the study period (sand shrimp and blue crab accounted for the majority of the impingements) and less than 1 percent of the total population in Barnegat Bay during that time. It is likely the winter flounder impingement losses are actually lower than those described in EA (1986) because they did not reflect the high survival observed in impinged organisms (77 to 94 percent) (Summers et al. 1989). Although thermal fluctuations associated with OCNGS operations have caused significant fish kills, winter flounder have not been among the affected species (Kennish 2001).

On the basis of the results of OCNGS studies (EA 1986; Summers et al. 1989) and the results reported in Kennish (2001), OCNGS operations have not resulted in discernable changes in invertebrate or fish communities in Barnegat Bay. OCNGS does not appear to adversely affect winter flounder egg EFH, since the eggs are demersal, adhesive, and occur in clusters. OCNGS operations would likely have a minimal adverse effect on EFH for larvae, juveniles, adults, and spawning adults of the winter flounder.

Winter Skate (*Leucoraja ocellata*)

On the basis of the distribution patterns described in NMFS (2006c), Barnegat Bay may provide EFH for both juvenile and adult winter skate. This species is common along the Atlantic Coast, with a range extending from the Gulf of St. Lawrence to Cape Hatteras. The population center is believed to be on Georges Bank (NMFS 2003c). EFH for juvenile and adult winter skates includes sand- and gravel-bottom substrates at depths of up to 300 m. During the spring, juveniles are found in water temperatures ranging from 34 to 54 °F (1 to 12 °C), with the majority occurring in temperatures of 39 to 41 °F (4 to 5 °C) and a salinity range of 32 to 33 ppt. During the fall, juveniles occur in water temperatures ranging from 41 to 70 °F (5 to 21 °C), with peak abundances observed at 59 °F (15 °C) and in salinities of 32 and 33 ppt (NMFS 2003c). Adult winter skates are found year round at temperatures ranging from 36 to 52 °F (2 to 11 °C) and depths ranging from 31 to 60 m. Adults are typically found at salinities ranging from 30 to 36 ppt. Juvenile and adult winter skates are bottom feeders and preferred prey include

polychaetes and crustaceans. Crustaceans are believed to make up more than 50 percent of their diet (NMFS 2003c). Because this species generally occurs in water with salinities greater than 32 ppt, it is not likely that this species spends a significant amount of time in the western portion of Barnegat Bay. However, it may frequent the eastern portion where higher salinity exists near the Barnegat Inlet. Tatham et al. (1984) did not identify winter skate as a common species in Barnegat Bay, nor are juveniles or adults routinely impinged on OCNGS traveling screens (EA 1986; Summers et al. 1989). This species was not identified in OCNGS fish kills (Kennish 2001). Current OCNGS operations may entrain or impinge some winter skate prey, but there is no evidence that prey populations have been measurably affected. OCNGS operations would likely have a minimal adverse effect on winter skate EFH for juveniles and adults.

7.0 MITIGATION MEASURES

Three categories of impacts related to OCNGS operations that could influence EFH are: (1) release of heated cooling water containing biocides or other chemicals; (2) entrainment of eggs, larvae, or phytoplankton and zooplankton in the water column; and (3) impingement of juveniles or adults. These operations are regulated under a NJPDES permit that is currently under review for extension to April 30, 2009. The NJDEP developed a fact sheet (NJDEP 2005a) that describes the agency's assessment of impacts and potential mitigation alternatives that may be necessary to comply with Phase II requirements of Section 316(b) of the Clean Water Act.

The existing dilution-pump system was designed to mitigate thermal effects in the discharge canal, Oyster Creek, and Barnegat Bay. Water at ambient temperature is pumped directly from the intake canal to the discharge canal where it mixes with the heated discharged water. The dilution water serves to reduce the temperature of the discharged circulation water immediately. Such temperature reduction greatly reduces any potential thermal effects on EFH in the discharge canal, Oyster Creek, and Barnegat Bay.

The NJDEP has granted OCNGS a variance from thermal surface-water quality standards for heat and temperature pursuant to Section 316(a) of the Clean Water Act. This variance was granted based on the assessment by Summers et al. (1989) that the operation of OCNGS did not appear to produce long-term population or ecosystem level impacts. Thus, the draft NJPDES permit does not require additional mitigation measures for thermal discharges beyond those already stipulated in the existing permit, which include temperature monitoring at various locations near OCNGS and plant shutdown restrictions during December, January, February, and March to reduce the possibility of fish kills related to cold shock.

Current mitigation measures also are in place to reduce effects of impingement on EFH in Barnegat Bay, Forked River, and the intake canal. In 1984, the circulating-water intake was

fitted with 3/8-in.-mesh traveling screens with Ristroph buckets and a screen-wash and fish-return system. Impinged organisms are washed into or fall into the buckets; the buckets deliver the organisms into the fish-return system, which transports them to the discharge canal where the dilution water enters the canal. Such mitigation measures greatly reduce the effects of impingement on EFH, including various life stages of prey species, in the Barnegat Bay system.

The fact sheet also addresses the impacts of entrainment and impingement by evaluating the potential losses of representative important species using three population models: equivalent adult model, production foregone model, and spawning/nursery area of consequence model. Although the NJDEP acknowledged the conclusion of Summers et al. (1989) that OCNGS operations did not appear to produce "unacceptable, substantial long-term population and ecosystem level impacts," the agency stated that it is not necessary to prove that an impact on a population is occurring to trigger the 2004 EPA Phase II Section 316(b) requirements. The NJDEP went on to state that "this rationale is consistent with the Phase II regulations which specify compliance alternatives, including national performance standards, and do not define adverse environmental impact." The National entrainment performance standard requires that entrainment mortality for all life stages of fish and shellfish be reduced by 60 to 90 percent from the calculated baseline, though there is no guidance on how the baseline is to be calculated. Impingement mortality is to be reduced by 80 to 90 percent from the calculated baseline. In addition to compliance with these performance standards, the NJDEP has indicated that AmerGen should initiate a wetlands restoration and enhancement program, within the Barnegat Bay estuary, to offset any residual impingement and entrainment losses at the facility. If such mitigation were to occur, it is likely that the potential impact of OCNGS activities on EFH would be further reduced during the license renewal period.

8.0 CONCLUSION

The expected impacts of OCNGS operations on EFH is summarized in Table 5. Because OCNGS operates a once-through cooling system, it has the potential to create a substantial adverse impact on EFH due to the withdrawal of water from the Forked River and Barnegat Bay. However, the general lack of interaction between EFH species and the facility, as well as current mitigation measures in place at OCNGS, reduce the potential adverse effect on EFH. OCNGS operations do not have an adverse effect on the food web in Barnegat Bay. The NRC staff concludes that license renewal for OCNGS for an additional 20 years of operation would result in a minimal adverse effect on EFH.

Table 5. Impacts of OCNGS Operations on EFH

Species	Life Stage	EFH Description	Expected Effect of OCNGS Operations on EFH
Black sea bass	Juveniles	Shallow water hard substrate with refuge. Temperatures of 17 to 25°C, and salinity of 18 to 22 ppt.	**Minimal Adverse Effect.** Probably does not frequent nearshore areas near OCNGS and not commonly impinged. Prey items are entrained or impinged at OCNGS, but prey population size not affected.
Bluefish	Juveniles	Habitat requirements not specified. Summer cohort temperatures of 20 to 30°C, and salinity of 31 to 36 ppt.	**Minimal Adverse Effect.** Not commonly impinged. Some documented thermal shock mortality. Prey items are entrained or impinged at OCNGS, but prey population size not affected.
Clearnose skate	Juveniles	Soft-bottom substrate. Temperatures of 9 to 20°C, and salinity of 31 to 35 ppt.	**Minimal Adverse Effect.** Not common in Barnegat Bay or commonly impinged, no documented thermal shock mortality. Prey items are entrained or impinged at OCNGS, but prey population size not affected.
	Adults	Same as juveniles	**Minimal Adverse Effect.** Same as juveniles.
Dusky shark	Neonates and juveniles	Shallow coastal waters to 25 m. Temperature of about 19°C, and salinity of >30 ppt.	**Minimal Adverse Effect.** Not common in Barnegat Bay or commonly impinged, no documented thermal shock mortality. Prey items are entrained or impinged at OCNGS, but prey population size not affected.
Little skate	Juveniles	Shallow coastal water and estuaries (5 to 8 m). Temperatures of 0 to 7°C (winter), and 14 to 22°C (summer). Salinity of 15 to 35 ppt.	**Minimal Adverse Effect.** Not common in Barnegat Bay or commonly impinged, no documented thermal shock mortality. Prey items are entrained or impinged at OCNGS, but prey population size not affected.
	Adults	Same as juveniles.	**Minimal Adverse Effect.** Same as juveniles.
Red hake	Eggs	Surface waters of mid-Atlantic region. Temperature of <10°C, and salinity of <25 ppt.	**No Adverse Effect.** Not commonly entrained.
	Larvae	Surface waters of mid-Atlantic region. Temperature of <19°C, and salinity of >0.5 ppt.	**Minimal Adverse Effect.** Not commonly entrained. Prey items are entrained at OCNGS, but prey population size not affected.

Table 5. (contd)

Species	Life Stage	EFH Description	Expected Effect of OCNGS Operations on EFH
Sandbar shark	Neonates and juveniles	Shallow coastal waters (25 to 200 m). Temperature of >21°C, and salinity of >22 ppt.	**Minimal Adverse Effect.** Not common in Barnegat Bay or commonly impinged, no documented thermal shock mortality. Prey items are entrained or impinged at OCNGS, but prey population size not affected.
	Adults	Shallow coastal waters (<50 m). Temperature and salinity similar to coastal estuaries with oceanic influence.	**Minimal Adverse Effect.** Same as juveniles.
Scup	Juveniles	Sandy or muddy habitat. Temperature of >7°C, and salinity of >15 ppt.	**Minimal Adverse Effect.** Not common in Barnegat Bay or commonly impinged. Some documented thermal shock mortality. Prey items are entrained or impinged at OCNGS, but prey population size not affected.
	Adults	Same as juveniles.	**Minimal Adverse Effect.** Same as juveniles.
Summer flounder	Juveniles	Coastal estuaries with seagrass, mudflats, or open areas. Temperature of >3°C, and salinity 10 to 30 ppt.	**Minimal Adverse Effect.** Some annual impingement mortality, but no observed population impacts. No documented thermal shock mortality. Prey items are entrained or impinged at OCNGS, but prey population size not affected.
	Adults	Demersal waters over continental shelf, oceanic conditions.	**Minimal Adverse Effect.** Same as juveniles.
Surf clam	Juveniles	Coastal water in medium and coarse sand/gravel at water depths to 60 m.	**No Adverse Effect.** Limited distribution in Barnegat Bay. Prey abundance probably not influenced by operations.
	Adults	Same as juveniles.	**No Adverse Effect.** Same as juveniles.
Tiger shark	Neonates and juveniles	Shallow coastal waters to a depth of 200 m.	**Minimal Adverse Effect.** Not common in Barnegat Bay or commonly impinged. No documented thermal shock mortality. Prey items are entrained or impinged at OCNGS, but prey population size not affected.
Windowpane flounder	Eggs	Surface water with temperatures <20°C.	**Minimal Adverse Effect.** Limited distribution in Barnegat Bay. Eggs not commonly entrained.

Table 5. (contd)

	Species	Life Stage	EFH Description	Expected Effect of OCNGS Operations on EFH
1		Larvae	Same as eggs.	**Minimal Adverse Effect.** Limited distribution in Barnegat Bay. Larvae not commonly entrained. Prey items are entrained at OCNGS, but prey population size not affected.
2		Juveniles	Mud or fine-grained sand habitat at depths of 1 to 100 m. Temperature of <25°C, and salinity of 5.5 to 36 ppt.	**Minimal Adverse Effect.** Not common in Barnegat Bay or commonly impinged. No documented thermal shock mortality. Prey items are entrained or impinged at OCNGS, but prey population size not affected.
3		Adults	Mud or fine-grained sand habitat at depths of 1 to 75 m. Temperature of <26.8°C, and salinity of 5.5 to 36 ppt.	**Minimal Adverse Effect.** Same as juveniles.
4		Spawning adults	Mud or fine-grained sand habitat at depths of 1 to 75 m. Temperature of <21°C, and salinity of 5.5 to 36 ppt.	**Minimal Adverse Effect** Same as juveniles.
5	Winter flounder	Eggs	Sand, muddy sand, and gravel habitat with depths of 0.3 to 4.5 m. Temperatures of 3 to 5°C, and salinity of 10 to 32 ppt.	**No Adverse Effect** Eggs demersal and adhesive. Not reported from entrainment samples.
6		Larvae	Shallow (1 to 4.5 m) inshore areas with fine sand to gravel substrate. Temperatures of 3 to 5°C, and salinity of 10 to 32 ppt.	**Minimal Adverse Effect.** Some annual entrainment loss. No documented thermal shock mortality. Prey items entrained at OCNGS, but prey population size not affected.
7		Juveniles	Mud or sand habitat with shell hash. Water depths of 0.5 to 27 m, temperatures of 2 to 29°C, and salinity of 19 to 33 ppt.	**Minimal Adverse Effect.** Some annual impingement loss, but no documented thermal shock mortality. Prey items are entrained or impinged at OCNGS, but prey population size not affected.
8		Adults	Mud, sand, or large cobble substrate, depths of 1 to 30 m. Temperatures of 12 to 15°C, and salinity of 15 to 33 ppt.	**Minimal Adverse Effect.** Same as juveniles.
9		Spawning adults	Same as adults.	**Minimal Adverse Effect.** Same as juveniles.

Table 5. (contd)

Species	Life Stage	EFH Description	Expected Effect of OCNGS Operations on EFH
Winter skate	Juveniles	Sand and gravel substrates to 300 m. Springtime temperatures of 4 to 5°C, and salinities of 28 to 32 ppt. Fall temperatures of 5 to 21°C, with peak abundance at 15°C, and salinities of 31 to 35 ppt.	**Minimal Adverse Effect.** Not common in Barnegat Bay or commonly impinged. No documented thermal shock mortality. Prey items are entrained or impinged at OCNGS, but prey population size not affected.
	Adult	Sand and gravel substrates to 300 m. Springtime temperatures of 4 to 5°C and salinities of 28 to 32 ppt. Fall temperatures of 5 to 21°C, with peak abundance at 15°C and salinities of 31 to 35 ppt.	**Minimal Adverse Effect.** Same as juveniles.

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UNITED STATES DEPARTMENT OF COMMERCE
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SEP 28 2006

Mr. Frank Gillespie, Director
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Office of Nuclear Reactor Regulation
United States Nuclear Regulatory Commission
Washington, D.C. 20555-0001

RE: Essential Fish Habitat Consultation Regarding License Renewal of Oyster Creek Nuclear Generating Station (TAC NO. MC7625)

ATTN: Dr. Michael Masnik, Senior Environmental Project Manager

Dear Mr. Gillespie:

The National Marine Fisheries Service (NMFS) has reviewed the essential fish habitat assessment that is contained within the draft supplement 28 to NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (GEIS). The GEIS evaluates the proposed renewal of the operating license for the Oyster Creek Nuclear Generating Station (OCNGS), located in Lacey Township in Ocean County, New Jersey, for a period of an additional 20 years. We have submitted letters concerning the adverse effects to aquatic resources associated with the operation of this plant over the past three decades. The GEIS indicates that the plant has incurred adverse impacts on the estuarine community of Oyster Creek, the South Branch of Forked River, and a major portion of Barnegat Bay through its thermal discharge and cooling water intake facilities.

The supplement environment impact statement (SEIS) that was prepared by the U.S. Nuclear Regulatory Commission (NRC) evaluates the proposed action of license renewal for OCNGS and initiates an essential fish habitat consultation. The essential fish habitat assessment is included in Appendix E of the draft SEIS.

Project Background:

OCNGS employs a once-through cooling system designed to remove waste heat from the condensers. The circulating water system includes the intake canal, an intake structure divided into two bays, circulating water pumps, condensers, dilution pumps, discharge pipes, and the discharge canal. The system is capable of pumping as much as 1.25 million gallons per minute (gpm), but typically pumps less then one million gpm. An angled boom in the intake canal is immediately in front of the circulating water intake, preventing large mats of aquatic plant material, such as eelgrass (*Zostera marina*) and algae, from clogging the intake system. One purpose of the dilution pumps is to decrease

the attraction of migrating species of fish to the heated discharge during the fall, so that they will not remain in the estuary and become trapped by the heated discharge in the winter. Another purpose is to reduce thermal stress on the organisms in the discharge canal during the summer.

Barnegat Bay is the plant's cooling water source and heat sink. Cooling water is drawn from Barnegat Bay through the South Branch of Forked River and into a 150-foot-wide discharge canal, which also receives dilution water at ambient temperature; the water then flows to Oyster Creek and back to Barnegat Bay. Depths in the South Branch of the Forked River, canals, and lower reaches of Oyster Creek are maintained by periodic dredging.

Impacts on Aquatic Resources from Operation of the Cooling Water Intake

Page 4-17 of the document notes that impingement mortality studies were conducted between 1975 and 1978, and then again in 1985. We note concern that the latest study in the time series was conducted in 1985, 21 years ago. Table 4.5 summarizes the number of organisms impinged and the mortality significance for bay anchovy ((*Anchoa mitchilli)*, Atlantic menhaden (*Brevoortia tyrannus*), blue crab (*Callinectes sapidus*), sand shrimp (*Crangon septemspinosa*), Atlantic silverside (*Menidia menidia*), and winter flounder (*Pseudopleuronectes americanus)*. The average annual impingement loss ranges from 13,000 winter flounder to eight million sand shrimp. Table 4.3 also lists hard clam (*Mercenaria mercenaria)*, and opossum shrimp (*Neomysis integer*), including the organisms listed in Table 4.5, as organisms regularly entrained in large numbers. Despite large numbers of organisms impinged and entrained, the document notes that NRC staff concludes that potential impacts on fish and shellfish would be small, but acknowledges that compliance with EPA's phase II regulations may require modification of the facility.

The Alternatives Section of this document notes that a once-through (closed cycle) cooling system would result in a 70% decrease in water intake rates, which would likely result in a proportionate decrease in the number of impinged organisms.

Impacts on Aquatic Resources from the Cooling Water Discharge

Page 4-22 of the document discusses the history and effects of the thermal discharge, noting the possible need to modify thermal discharges, noting a high number of fish kills, likely caused by thermal shock due to an interruption of the heated effluent, especially during winter months. The document notes that NRC staff has concluded that, with plant changes in operation to regulate thermal discharges, and with expanded monitoring of the aquatic environment, potential impacts on fish and shellfish were determined to be small. We agree that operation changes and expanded monitoring have reduced the potential impact on fisheries, but do so with the caution that past fish kills, as with all fish kills, were likely underestimated. Many expired fish may have never surfaced for observation, and many of those that did surface were consumed by birds. In addition, we note that past fish kills often occurred as a result of emergency or unscheduled plant shutdowns,

especially in the winter. The document does not indicate how such emergency or unscheduled shutdowns which can result in fish kills would be less likely in the future.

Essential Fish Habitat Comments:

Fourteen federally managed species with EFH designations within the vicinity of OCNGS were identified in the EFH assessment. Of these, according to NRC's assessment, thirteen federally managed species could receive a substantial adverse effect due to the withdrawal of water via a once-through cooling system. However, the conclusion on page E-61 states that "OCNGS operations do not have an adverse effect on the food web in Barnegat Bay;" that "current mitigation measures reduce the potential adverse effect on EFH; and that "an additional 20 years of operation would result in a minimal adverse effect on EFH." The NRC has also determined that continued operation of the OCNGS' cooling system, with its existing mitigation measures, is expected to have a minimal adverse effect on EFH.

NMFS does not concur with the conclusion of the EFH assessment. The history of the plant operation, as documented throughout the GEIS, shows that thermal, entrainment, and impingement impacts are directly impacting EFH species and their prey species. These impacts have been well documented and the OCNGS operation continues to have direct and cumulative effects.

According to Table 5 of Appendix E of the SEIS (the EFH assessment), prey items consumed by twelve EFH species are regularly entrained or impinged at OCNGS. These species are black sea bass, bluefish, clearnose skate, dusky shark, little skate, red hake, sandbar shark, scup, summer flounder, tiger shark, windowpane flounder, winter flounder, and winter skate (Steimle, et al. 2000). Of the prey items, bay anchovy, sand shrimp, blue crab, and silversides are impinged or entrained in significant numbers, according to the document. In addition, four species, bluefish, scup, summer flounder, and winter flounder, have some life stage commonly destroyed by thermal, entrainment, or impingement impacts. Of these four species, winter flounder mortalities through impingement and entrainment are of greatest concern as the mortalities are relatively high in relation to the population. Collectively, the species represent a trophic hierarchy that receives food web impacts which are relevant to NRC statement above as "substantially adverse."

NMFS is particularly concerned about the OCNGS's cooling system's impact on winter flounder because recruitment of winter flounder has been below average since 1989; and the 2001 year class appears to be the smallest in 22 years (NEFSC 2003).

According to the NJDEP's Fact Sheet, NJPDES #NJ000550 regarding the OCNGS's Surface Water Renewal Permit Action, a "closed cycle cooling is the only cooling water intake structure technology available to the facility to reduce entrainment." NMFS agrees that "a closed cycle cooling serves to significantly limit the amount of intake flow and thereby reduces both impingement and entrainment."

Essential Fish Habitat Recommendations:

To minimize the impacts on EFH, pursuant to Section 305(b)(4)(A) of the MSA, NMFS recommends that the following conservation recommendation be adopted:

Implement the best available technology to mitigate impingement, entrainment, and thermal impacts. This is apparently best represented by the use of cooling towers to place the plant on a closed cycle cooling system. A closed cycle cooling system would reduce the water intake rates by 70%, and likely result in a proportionate reduction in fish and shellfish mortalities.

Please note that Section 305(b)(4)(B) of the MSA requires that the NRC provide NMFS with a detailed written response to this EFH conservation recommendation, including a description of measures adopted by the NRC for avoiding, mitigating, or offsetting the impact of the project on EFH. In the case of a response that is inconsistent with NMFS' recommendation, Section 305(b)(4)(B) of the MSA also indicates that the NRC must explain it reasons for not following the recommendation. Included in such reasoning would be the scientific justification for any disagreements with NMFS over the anticipated effect of the proposed action and the measures needed to avoid, minimize, mitigate, or offset such effect pursuant to 50 CFR 600.920(k).

Please also note that a distinct and further EFH consultation must be reinitiated pursuant to 50 CFR 600.920(l), if new information becomes available or the project is revised in such a manner that affects the basis for the above EFH conservation recommendation.

Endangered Species Act (ESA)

Endangered and threatened Sea turtles may be present in the project area. The NRC is currently in consultation with the NMFS Northeast Region's Protected Resources Division pursuant to Section 7 of the ESA and the NRC will conclude the ESA consultation with this division of NMFS.

If you have any questions regarding these comments or need additional information, please contact Stan Gorski at 732-872-3037.

Sincerely,

Peter D. Colosi, Jr.
Assistant Regional Administrator
for Habitat Conservation

cc: PRD -- M. Colligan

Literature Cited:

Steimle, F.W., R.A. Pikanowski, D.G. McMillan, C.A. Zetlin, S.J. Wilk. 2000. Demersal fish and American lobster diets in the Lower Hudson-Raritan Estuary. NOAA Technical Memorandum NMFS-NE-161. Woods Hole, MA. 106 p.

[NEFSC] Northeast Fisheries Science Center. 2003. Report of the 36th Northeast Regional Stock Assessment Workshop (36th SAW): Stock Assessment Review Committee (SARC) consensus summary of assessments. Northeast Fish. Sci. Cent. Ref. Doc. 03-06.

published July 20, 2005

New Jersey Department of Environmental Protection
Division of Water Quality
Bureau of Point Source Permitting Region 1

PUBLIC NOTICE

Notice is hereby given that the New Jersey Department of Environmental Protection (NJDEP) proposes to renew the New Jersey Pollutant Discharge Elimination System (NJPDES) Discharge to Surface Water (DSW) Permit NJ0005550 in accordance with N.J.A.C. 7:14A-1 et seq., and by authority of the Water Pollution Control Act at N.J.S.A. 58:10A-1 et seq., for the following discharge:

Applicant or Permittee	Facility
Amergen LLC P.O. Box 388 – Oyster Creek Generating Station Forked River, NJ 08731-0388	Oyster Creek Generating Station RT 9 South Forked River, Ocean County, NJ

The Oyster Creek Generating Station (Station) is an existing nuclear fueled electric generating station. The Station is located between the South Branch of the Forked River and Oyster Creek, two tributaries of Barnegat Bay. This draft permit renewal proposes to authorize the intake of waters from Forked River as well as the discharge of wastewater through seven outfalls to both Forked River and Oyster Creek. The Station withdraws approximately 596 million gallons per day (MGD) of water from an intake canal that leads from the Forked River, uses this water as non-contact cooling water, then discharges these waters into a discharge canal which leads to Oyster Creek, classified as SE-1 waters. The plant also withdraws approximately 732 MGD of water from the intake canal and discharges it directly into the discharge canal (without added heat) for the purpose of diluting the thermal discharge from the non-contact cooling water. This permit also serves to authorize the discharge of miscellaneous non-contact cooling water, process wastewater, intake screen washwater and stormwater in minimal amounts through five other outfalls.

This draft permit renewal incorporates NJDEP's determination with respect to the permittee's request for a thermal variance from surface water quality standards (SWQS) for heat and temperature pursuant to Section 316(a) of the Federal Clean Water Act. Further, this draft renewal permit incorporates NJDEP's determination pursuant to Section 316(b) of the Clean Water Act regarding the best technology available for the cooling water intake structure and implements the newly effective Federal regulations for Phase II facilities. This permit contains a compliance schedule to implement Section 316(b) requirements.

Modification provisions as cited in the permit may be initiated in accordance with the provisions set forth in Part IV and upon written notification from the Department.

A draft NJPDES permit renewal has been prepared for this facility based on the administrative record filed at the NJDEP, 401 East State Street, Trenton, New Jersey 08625. Copies of the draft document are obtainable, for a nominal charge, and the administrative record is available for inspection by appointment only, Monday through Friday. If you are interested in scheduling an appointment or requesting specific information regarding the draft document, contact Susan Rosenwinkel of the Bureau of Point Source Permitting at (609) 292-4860.

Written comments on the draft document must be submitted in writing to Howard B. Tompkins Chief, or Attention: Comments on Public Notice NJ0005550, Bureau of Point Source Permitting Region 1, P.O. Box 029, Trenton, NJ 08625 by September 6, 2005. All persons, including the applicant, who believe that any condition of this draft document is inappropriate or that the Department's decision to issue this draft document is inappropriate, must raise all reasonable arguments and factual grounds supporting their position, including all supporting materials, during the public comment period.

NJDEP will also hold a non-adversarial public hearing to solicit public comment on the draft permit on Monday, August 29, 2005 from 1 to 4 PM and from 7 PM to end of testimony (or 9 PM) at:

Lacey Township Municipal Building
818 Lacey Road
Lacey Township, Ocean County, NJ

The NJDEP will respond to all significant and timely comments upon issuance of the final document. The permittee and each person who has submitted written comments will receive notice of the Department's permit decision.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Habitat Conservation Division
James J. Howard Marine
Sciences Laboratory
74 Magruder Road
Highlands, NJ 07732

November 7, 2005

Howard B. Tompkins, Chief
New Jersey Department of Environmental Protection
Division of Water Quality
Bureau of Point Source Permitting Region 1
P.O. Box 029
Trenton, NJ 08625

ATTN: Susan Rosenwinkel

SUBJECT: Comments on Public Notice NJ000550

Dear Mr. Tompkins:

We are responding to the public notice for AmerGen LLC to renew the New Jersey Pollutant Discharge Elimination System (NJPDES) Discharge to Surface Water (DSW) Permit NJ0005550 for the Oyster Creek Generating Station on Route 9 South, Forked River, Ocean County, NJ

The Oyster Creek Generating Station (Station), which is an existing nuclear fueled electric generating station, located between the South Branch of the Forked River and Oyster Creek, takes in water from Forked River and discharges wastewater to Forked River and Oyster Creek. The Station withdraws approximately 596 million gallons of water per day from an intake canal that leads from the Forked River, uses this water as non-contact cooling water, and then discharges these waters into a discharge canal which leads to Oyster Creek. The plant also withdraws approximately 732 million gallons of water per day from the intake canal and discharges it directly in to the discharge canal for the purpose of diluting the thermal discharge from the non-contact cooling water.

The rich and diverse marine life found in the Station area is discussed in the Environmental Report, Section 2.2 Aquatic Ecological Communities, from the Oyster Creek Generating Station License Renewal Application. Fisheries impacts due to thermal impacts and impingement and entrainment impacts due to the Station's operation are well documented. The National Marine Fisheries Service has been providing comments regarding these negative effects for over thirty years. We continue to state that the Station operation has incurred, and will continue to incur, significant adverse impacts to the estuarine community of Oyster Creek, the South Branch of Forked River and a major portion of Barnegat Bay, New Jersey, through its thermal discharge and intake facilities.

It is our understanding that the U.S. Nuclear Regulatory Commission (NRC) is the lead federal action agency for this project and will be conducting an essential fish habitat consultation with us in compliance with Section 305 of the Magnuson-Stevens Fishery Conservation and Management Act, which includes an assessment of the Station's impacts to essential fish habitat.

The National Marine Fisheries Service recommends that the New Jersey Department of Environmental Protection mandate the implementation of the best available technology to mitigate impingement, entrainment impacts and thermal impacts which is best represented by the use of cooling towers.

If you wish to discuss this further, please contact Anita Riportella at 732-872-3116 or anita.riportella@noaa.gov

Sincerely,

Stanley W. Gorski
Field Offices Supervisor

cf: EPA, Region II
USFWS, Pleasantville
NJDEP, Land Use Regulation
NJDEP, Fish and Wildlife

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

Response letter due in 30 days. BO due 135 days

June 9, 2006

RECEIVED JUN 15 2006

135 days = October 28

Ms. Patricia Kurkul
Regional Administrator
NOAA Fisheries Service
Northeast Regional Office
One Blackburn Drive
Gloucester, MA 01930-2237

SUBJECT: REQUEST INITIATION OF A SECTION 7 CONSULTATION REGARDING LICENSE RENEWAL OF OYSTER CREEK NUCLEAR GENERATING STATION (TAC NO. MC7625)

Dear Ms. Kurkul:

The U.S. Nuclear Regulatory Commission (NRC) staff has completed the enclosed draft Supplement 28 to NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (GEIS), to evaluate the proposed renewal of the Oyster Creek Nuclear Generating Station (OCNGS) operating license for a period of an additional 20 years. The Supplemental Environmental Impact Statement (SEIS) evaluates the proposed action of license renewal for OCNGS, and the NRC is requesting initiation of a Section 7 consultation regarding this proposed action of license renewal.

On September 22, 2005, the National Marine Fisheries Service (NMFS) concluded a Section 7 consultation with the NRC regarding continued operation of OCNGS; the consultation was triggered by an exceedance of the incidental take limit for Kemp's ridley turtles (*Lepidochelys kempi*). Now the NRC is requesting initiation of another Section 7 consultation without submitting a revised Biological Assessment (BA). As a result of e-mail and telephone communications with Ms. Sara McNulty of your office and because this request closely follows the conclusion of the last Section 7 consultation, the NRC staff will not submit a revision to the BA dated March 29, 2005. Also, the NRC staff has not identified any changes in OCNGS operations since the conclusion of the last Section 7 consultation in September 2005. However, for your review, we have enclosed a copy of the draft SEIS, which has the most up-to-date information regarding OCNGS operations.

Since the NRC's 2005 BA, two incidental takes occurred at OCNGS; both takes were of Kemp's ridley turtles. On July 4, 2005, a dead juvenile male Kemp's ridley turtle was removed from the trash bars at the dilution water intake structure. The turtle was taken to the Marine Mammal Stranding Center (MMSC) for necropsy, the results of which indicate that the turtle likely died of wounds resulting from collision with a boat propeller. The second take was a live Kemp's ridley turtle found on the trash bars at the circulating water intake structure on August 5, 2005. The turtle was taken to the MMSC and then to the Sea Turtle Rescue and Rehabilitation Center in Topsail Beach, North Carolina, for rehabilitation.

OCNGS staff routinely follows standard protocols to remove sea turtles safely from the intake canal and works with the MMSC to rehabilitate injured sea turtles. The NRC staff has determined that license renewal for OCNGS may adversely affect but is not likely to jeopardize the continued existence of Kemp's ridley turtles, green turtles (*Chelonia mydas*), or loggerhead turtles (*Caretta caretta*); the proposed action is not likely to adversely affect leatherback turtles (*Dermochelys coriacea*) and hawksbill turtles (*Eretmochelys imbricata*).

We are requesting your concurrence with our determination. In reaching our conclusion, the NRC staff relied on information provided by the applicant, on research performed by NRC staff, and on information from NMFS. If you have any questions regarding the enclosed draft SEIS or the staff's request, please contact Dr. Michael Masnik, Senior Environmental Project Manager, at 301-415-1191 or by e-mail at mtm2@nrc.gov.

Sincerely,

Frank Gillespie, Director
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket No. 50-219

Enclosure:
Draft Supplement 28 to NUREG-1437

cc w/encl: See next page

cc:

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Mr. Christopher M. Crane
President and Chief Nuclear Officer
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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

June 9, 2006

received 6/15/06

Mr. Timothy Rausch
Site Vice President
Oyster Creek Nuclear Generating Station
AmerGen Energy Company, LLC
P.O. Box 388
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SUBJECT: NOTICE OF AVAILABILITY OF THE DRAFT PLANT- SPECIFIC SUPPLEMENT 28 TO THE GENERIC ENVIRONMENTAL IMPACT STATEMENT FOR LICENSE RENEWAL OF NUCLEAR PLANTS (GEIS) REGARDING OYSTER CREEK NUCLEAR GENERATING STATION (TAC NO. MC7625)

Dear Mr. Swenson:

The U.S. Nuclear Regulatory Commission (NRC) staff has completed the draft plant-specific Supplement 28 to NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants," (GEIS) regarding the renewal of operating license DPR-16 for an additional 20 years of operation for the Oyster Creek Nuclear Generating Station. Enclosed is a copy of the draft supplement and the associated *Federal Register* Notice of Availability. This notice advises the public that the draft supplement is publicly available at the NRC Public Document Room or from the NRC's Agencywide Documents Access and Management System (ADAMS). ADAMS is accessible from the NRC website at http://www/nrc.gov/reading-rm/adams/web-based.html. The accession number for the draft Supplement 28 to the GEIS is ML061520231. In addition, the Lacey Public Library, located at 10 East Lacey Road, Forked River, NJ 08731, has agreed to make the draft supplement to the GEIS available for public inspection.

As discussed in Section 9.3 of the draft supplement, the preliminary recommendation of the staff is that the Commission determine that the adverse environmental impacts of license renewal for the Oyster Creek Nuclear Generating Station are not so great that preserving the option of license renewal for energy planning decision makers would be unreasonable. This recommendation is based on: (1) the analysis and findings in the GEIS; (2) the Environmental Report submitted by AmerGen Energy Company, LLC; (3) consultation with Federal, State, and local agencies; (4) the staff's own independent review; and (5) the staff's consideration of public comments received during the scoping process.

A separate notice of filing of the draft supplemental environmental impact statement will be placed in the *Federal Register* through the U.S. Environmental Protection Agency. If you have any questions regarding this matter, please contact the NRC Environmental Project Manager, Dr. Michael Masnik, at 301-415-1191 or by e-mail at MTM2@nrc.gov.

Sincerely,

FOR

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

Docket No. 50-219

Enclosure:
Draft Supplement 28 to the GEIS

cc w/encl: See next page

UNITED STATES NUCLEAR REGULATORY COMMISSION

AMERGEN ENERGY COMPANY, LLC

OYSTER CREEK NUCLEAR GENERATING STATION

DOCKET NO. 50-219

NOTICE OF AVAILABILITY OF THE DRAFT SUPPLEMENT 28 TO THE GENERIC ENVIRONMENTAL IMPACT STATEMENT FOR LICENSE RENEWAL OF NUCLEAR PLANTS, AND PUBLIC MEETING FOR THE LICENSE RENEWAL OF OYSTER CREEK NUCLEAR GENERATING STATION

Notice is hereby given that the U.S. Nuclear Regulatory Commission (NRC, Commission) has published a draft plant-specific supplement to the Generic Environmental Impact Statement for License Renewal of Nuclear Plants (GEIS), NUREG-1437, regarding the renewal of operating license DPR-16 for an additional 20 years of operation for the Oyster Creek Nuclear Generating Station (OCNGS). OCNGS is located along the western shore of Barnegat Bay between the South Branch of Forked River and Oyster Creek, in Ocean County, New Jersey. Possible alternatives to the proposed action (license renewal) include no action and reasonable alternative energy sources.

The draft Supplement 28 to the GEIS is publicly available at the NRC Public Document Room (PDR), located at One White Flint North, 11555 Rockville Pike, Rockville, Maryland, 20852, or from the NRC's Agencywide Documents Access and Management System (ADAMS). The ADAMS Public Electronic Reading Room is accessible at http://www.nrc.gov/reading-rm/adams/web-based.html. The accession number for the draft Supplement 28 to the GEIS is ML061520231. Persons who do not have access to ADAMS, or who encounter problems in accessing the documents located in ADAMS, should contact the NRC's PDR Reference staff by

telephone at 1-800-397-4209, or 301-415-4737, or by e-mail at pdr@nrc.gov. In addition, the Lacey Public Library, located at 10 East Lacey Road, Forked River, NJ 08731, has agreed to make the draft supplement to the GEIS available for public inspection.

Any interested party may submit comments on the draft supplement to the GEIS for consideration by the NRC staff. To be certain of consideration, comments on the draft supplement to the GEIS and the proposed action must be received by September 8, 2006. Comments received after the due date will be considered if it is practical to do so, but the NRC staff is able to assure consideration only for comments received on or before this date. Written comments on the draft supplement to the GEIS should be sent to: Chief, Rules and Directives Branch, Division of Administrative Services, Office of Administration, Mailstop T-6D59, U.S. Nuclear Regulatory Commission, Washington, D.C., 20555-0001.

Comments may be hand-delivered to the NRC at 11545 Rockville Pike, Room T-6D59, Rockville, Maryland, between 7:30 a.m. and 4:15 p.m. on Federal workdays. Electronic comments may be submitted to the NRC by e-mail at OysterCreekEIS@nrc.gov. All comments received by the Commission, including those made by Federal, State, local agencies, Native American Tribes, or other interested persons, will be made available electronically at the Commission's PDR in Rockville, Maryland, and through ADAMS.

The NRC staff will hold a public meeting to present an overview of the draft plant-specific supplement to the GEIS and to accept public comments on the document. The public meeting will be held on July 12, 2006, at the Quality Inn located at 815 Route 37 in Toms River, New Jersey. There will be two sessions to accommodate interested parties. The first session will convene at 1:30 p.m. and will continue until 4:30 p.m., as necessary. The second session will convene at 7:00 p.m. with a repeat of the overview portions of the meeting and will continue until 10:00 p.m., as necessary. Both meetings will be transcribed and will include: (1) a presentation of the contents of the draft plant-specific supplement to the GEIS, and (2) the

opportunity for interested government agencies, organizations, and individuals to provide comments on the draft report. Additionally, the NRC staff will host informal discussions one hour prior to the start of each session at the same location. No comments on the draft supplement to the GEIS will be accepted during the informal discussions. To be considered, comments must be provided either at the transcribed public meeting or in writing. Persons may pre-register to attend or present oral comments at the meeting by contacting Dr. Michael Masnik, the NRC Environmental Project Manager at 1-800-368-5642, extension 1191, or by e-mail at OysterCreekEIS@nrc.gov no later than July 5, 2006. Members of the public may also register to provide oral comments within 15 minutes of the start of each session. Individual, oral comments may be limited by the time available, depending on the number of persons who register. If special equipment or accommodations are needed to attend or present information at the public meeting, the need should be brought to Dr. Masnik's attention no later than June 28, 2006, to provide the NRC staff adequate notice to determine whether the request can be accommodated.

FOR FURTHER INFORMATION, CONTACT: Dr. Michael Masnik, Environmental Branch B, Division of License Renewal, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Mail Stop O-11F1, Washington, DC, 20555-0001. Dr. Masnik may be contacted at the aforementioned telephone number or e-mail address.

Dated at Rockville, Maryland, this 6th day of June, 2006.

FOR THE NUCLEAR REGULATORY COMMISSION

Frank P. Gillespie, Director
Division of License Renewal
Office of Nuclear Reactor Regulation

Oyster Creek Nuclear Generating Station

cc:

Site Vice President - Oyster Creek
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Oyster Creek Nuclear Generating Station

cc:

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

June 9, 2006

received 6/15/06

U.S. Environmental Protection Agency
Office of Federal Activities
NEPA Compliance Division
EIS Filing Section
Ariel Rios Building (South Oval Lobby)
Mail Code 2252-A, Room 7241
1200 Pennsylvania Avenue, NW
Washington, DC 20460

SUBJECT: NOTICE OF AVAILABILITY OF THE DRAFT PLANT- SPECIFIC SUPPLEMENT 28 TO THE GENERIC ENVIRONMENTAL IMPACT STATEMENT FOR LICENSE RENEWAL OF NUCLEAR PLANTS (GEIS) REGARDING OYSTER CREEK NUCLEAR GENERATING STATION

Dear Sir or Madam:

The following documents are enclosed for official filing with the U.S. Environmental Protection Agency:

1. Five copies of the draft Supplement 28 to NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants," regarding the license renewal of Oyster Creek Nuclear Generating Station.

2. Five copies of the U.S. Nuclear Regulatory Commission's (NRC) distribution list for the draft Supplement 28 to NUREG-1437.

Simultaneously with this filing, a copy of the draft Supplement 28 is being mailed to interested Federal and State agencies, industry organizations, interest groups, and members of the public. A copy of this document has also been placed in the NRC's Agencywide Documents Access and Management System (ADAMS). ADAMS is located on the NRC's Web site at http://www.nrc.gov/reading-rm/adams/web-based.html. The accession number for the draft Supplement 28 to the GEIS is ML061520231. Please note that the public comment period for the draft Supplement 28 to the GEIS ends on September 8, 2006.

If further information is required, please contact the NRC Environmental Project Manager, Dr. Michael Masnik at 301-415-1191 or by e-mail at MTM2@nrc.gov.

Sincerely,

For

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

Docket Nos. 50-219

Enclosures:
As stated

cc w/encls: See next page

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rcvd 6/15/06

NUREG-1437
Supplement 28

Generic Environmental Impact Statement for License Renewal of Nuclear Plants

Supplement 28

Regarding
Oyster Creek Nuclear Generating Station

Draft Report for Comment

U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, DC 20555-0001

NUREG-1437
Supplement 28

Generic Environmental Impact Statement for License Renewal of Nuclear Plants

Supplement 28

Regarding Oyster Creek Nuclear Generating Station

Draft Report for Comment

Manuscript Completed: June 2006
Date Published: June 2006

Division of License Renewal
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

COMMENTS ON DRAFT REPORT

Any interested party may submit comments on this report for consideration by the NRC staff. Comments may be accompanied by additional relevant information or supporting data. Please specify the report number NUREG-1437, Supplement 28, draft, in your comments, and send them by September 8, 2006, to the following address:

Chief, Rules Review and Directives Branch
U.S. Nuclear Regulatory Commission
Mail Stop T6-D59
Washington, DC 20555-0001

Electronic comments may be submitted to the NRC by the Internet at OysterCreekEIS@nrc.gov.

For any questions about the material in this report, please contact:

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Abstract

The U.S. Nuclear Regulatory Commission (NRC) considered the environmental impacts of renewing nuclear power plant operating licenses (OLs) for a 20-year period in its *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2, and codified the results in Title 10, Part 51, of the *Code of Federal Regulations* (10 CFR Part 51). In the GEIS (and its Addendum 1), the NRC staff identifies 92 environmental issues and reaches generic conclusions related to environmental impacts for 69 of these issues that apply to all plants or to plants with specific design or site characteristics. Additional plant-specific review is required for the remaining 23 issues. These plant-specific reviews are to be included in a supplement to the GEIS.

This Draft Supplemental Environmental Impact Statement (SEIS) has been prepared in response to an application submitted to the NRC by AmerGen Energy Company, LLC (AmerGen), to renew the OL for Oyster Creek Nuclear Generating Station (OCNGS) for an additional 20 years under 10 CFR Part 54. This draft SEIS includes the NRC staff's analysis that considers and weighs the environmental impacts of the proposed action, the environmental impacts of alternatives to the proposed action, and mitigation measures available for reducing or avoiding adverse impacts. It also includes the NRC staff's preliminary recommendation regarding the proposed action.

Regarding the 69 issues for which the GEIS reached generic conclusions, neither AmerGen nor the NRC staff has identified information that is both new and significant for any issue that applies to OCNGS. In addition, the NRC staff determined that information provided during the scoping process did not call into question the conclusions in the GEIS. Therefore, the NRC staff concludes that the impacts of renewing the OCNGS OL would not be greater than the impacts identified for these issues in the GEIS. For each of these issues, the NRC staff's conclusion in the GEIS is that the impact is of SMALL[a] significance (except for collective offsite radiological impacts from the fuel cycle and high-level waste and spent fuel, which were not assigned a single significance level).

Regarding the remaining 23 issues, those that apply to OCNGS are addressed in this draft SEIS. For each applicable issue, the NRC staff concludes that the significance of the potential environmental impacts of renewal of the OL is SMALL. The NRC staff also concludes that additional mitigation measures are not likely to be sufficiently beneficial as to be warranted. The NRC staff determined that information provided during the scoping process did not identify any new issue that has a significant environmental impact.

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[a]Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.

The NRC staff's preliminary recommendation is that the Commission determine that the adverse environmental impacts of license renewal for OCNGS are not so great that preserving the option of license renewal for energy-planning decisionmakers would be unreasonable. This recommendation is based on (1) the analysis and findings in the GEIS; (2) the Environmental Report submitted by AmerGen; (3) consultation with Federal, State, and local agencies; (4) the NRC staff's own independent review; and (5) the NRC staff's consideration of public comments received during the scoping process.

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

June 28, 2006

MEMORANDUM TO: Rani L. Franovich, Branch Chief
Environmental Branch B
Division of License Renewal
Office of Nuclear Reactor Regulation

FROM: Michael Masnik, Project Manager
Environmental Branch B
Division of License Renewal
Office of Nuclear Reactor Regulation

SUBJECT: FORTHCOMING MEETING TO DISCUSS THE DRAFT SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT FOR THE LICENSE RENEWAL OF OYSTER CREEK NUCLEAR GENERATING STATION

DATE AND TIME: Wednesday, July 12, 2006, (Two identical sessions)
First session: 1:30 p.m. - 4:30 p.m.
Second session: 7:00 p.m. - 10:00 p.m.

LOCATION: Grand Ballroom
Toms River Quality Inn
815 Route 37
Toms River, NJ 08755

CATEGORY 3:* This is a Category 3 Meeting. The public is invited to participate in this meeting by providing comments and asking questions throughout the meeting.

PURPOSE: To meet with the public to receive comments on the draft Supplement 28 to the Generic Environmental Impact Statement for License Renewal of Nuclear Plants (NUREG-1437) for Oyster Creek Nuclear Generating Station, issued on June 9, 2006. The draft Supplemental Environmental Impact Statement is available on the U.S. Nuclear Regulatory Commission's (NRC) Website http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1437/supplement28/index.html and in the NRC's publicly available Agencywide Document Access and Management System (ADAMS). The ADAMS Accession Number is ML061520231. See the enclosed agenda and *the Federal Register* Notice (71 FR 34969).

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* Commission's Policy Statement on "Enhancing Public Participation in NRC Meetings," 67 *Federal Register* 36920, May 28, 2002

PURPOSE (Cont.): Both formal sessions will be preceded by an informal "open house" beginning one hour prior to each session for those who wish to attend. The open house will provide members of the public with an opportunity to talk informally one-on-one with NRC staff. Members of the public may register to present oral comments at this meeting by contacting Michael Masnik, at (800) 368-5642, ext. 1191, or by e-mail at OysterCreekEIS@nrc.gov by July 3, 2006. Those who wish to make comments may also register at the meeting within 15 minutes of the start of each session. Individual oral comments may be limited by the time available, depending on the number of persons who register. Dr. Masnik will need to be contacted no later than July 3, 2006, if special equipment or accommodations are needed to attend or present information at the public meeting.

PARTICIPANTS:

NRC
Francis Cameron
Eric Benner
Michael Masnik
Robert Palla

Argonne National Laboratory
Kirk LaGory

Members of the Public Who Register to Speak

Docket No. 50-219

Enclosures:
1. Agenda
2. *Federal Register* Notice

cc w/enclosures: See next page

AGENDA FOR PUBLIC MEETINGS TO DISCUSS THE DRAFT SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT FOR THE LICENSE RENEWAL OF OYSTER CREEK NUCLEAR GENERATING STATION

JULY 12, 2006

Two Identical Sessions - 1:30 p.m. to 4:30 p.m. and 7:00 p.m. to 10:00 p.m.*

I. Welcome and Purpose of Meeting	10 minutes (F. Cameron)
II. Overview of License Renewal Process	10 minutes (M. Masnik)
III. Results of the Environmental Review	30 minutes (K. LaGory)
IV. How Comments can be Submitted	5 minutes (M. Masnik)
V. Public Comments	2 hours
VI. Closing/Availability of Transcripts, etc.	5 minutes (F. Cameron)

*The NRC staff will host informal discussions one hour prior to each meeting session. No formal comments on the Draft Supplemental Environmental Impact Statement will be accepted during the informal discussions. To be considered, comments must be provided either at the transcribed public meetings (see agenda, above) or in writing, as described in the enclosed *Federal Register* Notice.

Enclosure 1

[Federal Register: June 16, 2006 (Volume 71, Number 116)]
[Notices]
[Page 34969]
From the Federal Register Online via GPO Access [wais.access.gpo.gov]
[DOCID:fr16jn06-151]

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NUCLEAR REGULATORY COMMISSION

[Docket No. 50-219]

Amergen Energy Company, LLC; Oyster Creek Nuclear Generating Station; Notice of Availability of the Draft Supplement 28 to the Generic Environmental Impact Statement for License Renewal of Nuclear Plants, and Public Meeting for the License Renewal of Oyster Creek Nuclear Generating Station

Notice is hereby given that the U.S. Nuclear Regulatory Commission (NRC, Commission) has published a draft plant-specific supplement to the Generic Environmental Impact Statement for License Renewal of Nuclear Plants (GEIS), NUREG-1437, regarding the renewal of operating license DPR-16 for an additional 20 years of operation for the Oyster Creek Nuclear Generating Station (OCNGS). OCNGS is located along the western shore of Barnegat Bay between the South Branch of Forked River and Oyster Creek, in Ocean County, New Jersey. Possible alternatives to the proposed action (license renewal) include no action and reasonable alternative energy sources.

The draft Supplement 28 to the GEIS is publicly available at the NRC Public Document Room (PDR), located at One White Flint North, 11555 Rockville Pike, Rockville, Maryland 20852, or from the NRC's Agencywide Documents Access and Management System (ADAMS). The ADAMS Public Electronic Reading Room is accessible at http://www.nrc.gov/reading-rm/adams/web-based.html.

The accession number for the draft Supplement 28 to the GEIS is ML061520231. Persons who do not have access to ADAMS, or who encounter problems in accessing the documents located in ADAMS, should contact the NRC's PDR Reference staff by telephone at 1-800-397-4209, or 301-415-4737, or by e-mail at pdr@nrc.gov. In addition, the Lacey Public Library, located at 10 East Lacey Road, Forked River, NJ 08731, has agreed to make the draft supplement to the GEIS available for public inspection.

Any interested party may submit comments on the draft supplement to the GEIS for consideration by the NRC staff. To be certain of consideration, comments on the draft supplement to the GEIS and the

proposed action must be received by September 8, 2006. Comments received after the due date will be considered if it is practical to do so, but the NRC staff is able to assure consideration only for comments received on or before this date. Written comments on the draft supplement to the GEIS should be sent to: Chief, Rules and Directives Branch, Division of Administrative Services, Office of Administration, Mailstop T-6D59, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001.

Comments may be hand-delivered to the NRC at 11545 Rockville Pike, Room T-6D59, Rockville, Maryland, between 7:30 a.m. and 4:15 p.m. on Federal workdays. Electronic comments may be submitted to the NRC by e-mail at OysterCreekEIS@nrc.gov. All comments received by the Commission, including those made by Federal, State, local agencies, Native American Tribes, or other interested persons, will be made available electronically at the Commission's PDR in Rockville, Maryland, and through ADAMS.

The NRC staff will hold a public meeting to present an overview of the draft plant-specific supplement to the GEIS and to accept public comments on the document. The public meeting will be held on July 12, 2006, at the Quality Inn located at 815 Route 37 in Toms River, New Jersey. There will be two sessions to accommodate interested parties. The first session will convene at 1:30 p.m. and will continue until 4:30 p.m., as necessary. The second session will convene at 7 p.m. with a repeat of the overview portions of the meeting and will continue until 10 p.m., as necessary. Both meetings will be transcribed and will include: (1) A presentation of the contents of the draft plant-specific supplement to the GEIS, and (2) the opportunity for interested government agencies, organizations, and individuals to provide comments on the draft report. Additionally, the NRC staff will host informal discussions one hour prior to the start of each session at the same location. No comments on the draft supplement to the GEIS will be accepted during the informal discussions. To be considered, comments must be provided either at the transcribed public meeting or in writing. Persons may pre-register to attend or present oral comments at the meeting by contacting Dr. Michael Masnik, the NRC Environmental Project Manager at 1-800-368-5642, extension 1191, or by e-mail at OysterCreekEIS@nrc.gov no later than July 5, 2006. Members of the public may also register to provide oral comments within 15 minutes of the start of each session. Individual, oral comments may be limited by the time available, depending on the number of persons who register. If special equipment or accommodations are needed to attend or present information at the public meeting, the need should be brought to Dr. Masnik's attention no later than June 28, 2006, to provide the NRC staff adequate notice to determine whether the request can be accommodated.

For Further Information Contact: Dr. Michael Masnik, Environmental Branch B, Division of License Renewal, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Mail Stop O-11F1, Washington, DC 20555-0001. Dr. Masnik may be contacted at the aforementioned telephone number or e-mail address.

Dated at Rockville, Maryland, this 6th day of June, 2006.

For the Nuclear Regulatory Commission.
Frank P. Gillespie,
Director, Division of License Renewal,Office of Nuclear Reactor Regulation.
[FR Doc. E6-9057 Filed 6-15-06; 8:45 am]
BILLING CODE 7590-01-P

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Oyster Creek Nuclear Generating Station

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UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
NORTHEAST REGION
One Blackburn Drive
Gloucester, MA 01930-2298

JUL - 7 2006

Frank Gillespie, Director
Division of License Renewal
Office of Nuclear Reactor Program
United States Nuclear Regulatory Commission
Washington, DC 20555-0001

Dear Mr. Gillespie,

This is in response to your letter dated June 9, 2006 regarding a request for formal consultation pursuant to Section 7 of the Endangered Species Act (ESA) of 1973, as amended, for the US Nuclear Regulatory Commission's (NRC) proposed renewal of the operating license for the Oyster Creek Nuclear Generating Station (OCGNS). The facility's current license expires on April 9, 2009 and the NRC proposes to renew the license for an additional 20 years.

The OCGNS is operated by AmerGen Energy Company, LLC (AmerGen) and is located in Lacey Township, New Jersey. Section 7 consultation was last completed with NOAA's National Marine Fisheries Service in 2005 with a Biological Opinion (Opinion) dated September 22, 2005 concluding that continued operation of the OCGNS through the end of its current license period was not likely to jeopardize the continued existence of listed sea turtles.

The sea turtles in northeastern nearshore waters are typically small juveniles with the most abundant being the federally threatened loggerhead (*Caretta caretta*) followed by the federally endangered Kemp's ridley (*Lepidochelys kempi*). Loggerheads and Kemp's ridleys have been documented in waters as cold as 11°C, but generally migrate northward when water temperatures exceed 16°C. Sea turtles are typically present in New Jersey waters from May 1 – November 15, with the majority of sea turtles in the area from late May to early November. Concentrations of the federally endangered leatherbacks (*Dermochelys coriacea*) have been observed during the summer off New Jersey. While leatherbacks are predominantly pelagic, they may occur close to shore, especially when pursuing their preferred jellyfish prey. Green sea turtles *(Chelonia mydas)* may also occur in New Jersey waters in warmer months.

The OCNGS began commercial operation in 1969. A Biological Opinion on the effects of the operation of the facility on listed species under NMFS jurisdiction was issued on September 21, 1995. Consultation was reinititated in 2000 with an Opinion being issued by NMFS on July 18, 2001. In 2004, the number of Kemp's ridleys impinged at the facility's intake exceeded the number exempted by the Incidental Take Statement issued with the 2001 Opinion. Consultation was reinitated in early 2005 with an Opinion issued by NMFS on September 22, 2005. The ITS

accompanying this Opinion exempts the annual take of two loggerheads (one lethal), eight Kemp's ridleys (four lethal), and one lethal take of a green sea turtle.

From the information provided in the Environmental Impact Statement (EIS) for the facility, the June 9, 2006 letter as well as the documented effects of the facility on sea turtles, NMFS has concluded that the proposed license renewal may affect listed sea turtles. The purpose of this letter, therefore, is to concur with the need for the initiation of formal consultation on the issuance of a license renewal by NRC to allow the continued operation of the OCNGS past April 9, 2009 when the current license expires. All of the information required to initiate a formal consultation has been received. The correspondence with your office, the EIS dated June 2006, the 2005 biological assessment and available commercial and scientific data will be used to prepare the Opinion.

The date your June 9, 2006 letter was received (June 15, 2006) will serve as the commencement of the formal consultation process. The ESA and the Section 7 regulations (50 CFR 402.14) require that formal consultation be concluded within 90 calendar days of initiation, and the biological opinion be delivered to the action agency within 45 days after the conclusion of formal consultation (i.e., October 28, 2006), unless extended. In the meantime, pursuant to Section 7d of the ESA, the NRC must not make any irreversible or irretrievable commitment of resources that would foreclose the formulation or implementation of any reasonable and prudent alternatives to avoid jeopardizing endangered or threatened species. We look forward to working with your office during the formal consultation process. If you have any questions or concerns about the consultation, please contact Julie Crocker at (978) 281-9300 ext. 6530 or by e-mail (julie.crocker@noaa.gov).

Sincerely,

Patricia A. Kurkul
Regional Administrator

cc: Scida, F/NER3
Williams, GCNE
Greene, F/NER4

File Code: Section 7 NRC New Jersey – Oyster Creek NGS 2006 consultation

PCTS: F/NER/2006/02883

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

August 10, 2006

LICENSEE: Amergen Energy Co., LLC.

FACILITY: Oyster Creek Nuclear Generating Station

SUBJECT: SUMMARY OF PUBLIC MEETINGS ON THE DRAFT SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT REGARDING OYSTER CREEK NUCLEAR GENERATING STATION LICENSE RENEWAL REVIEW (TAC NO. MC 7625)

On Wednesday, July 12, 2006, members of the U.S. Nuclear Regulatory Commission (NRC) staff held public meetings in Toms River, New Jersey, concerning the staff's environmental review of the application submitted by AmerGen Energy Co., LLC. for renewal of Oyster Creek Nuclear Generating Station's (OCNGS) operating license. The purpose of the meetings was to provide the public with an opportunity to comment on the draft supplemental environmental impact statement (DSEIS) which was issued in June 9, 2006. The public meetings were held at the Toms River Quality Inn, in Toms River, New Jersey. Formal presentations were made by the NRC staff and the Argonne National Laboratory (ANL) staff.

The DSEIS is a plant-specific supplement for OCNGS to the "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (NUREG-1437). The NRC staff described the overall license renewal process, provided a description of the National Environmental Policy Act review process, and discussed the environmental requirements outlined in Title 10 of the Code of *Federal Regulations* Part 51 (10 CFR Part 51). The NRC staff also described the preliminary results of their analyses. The environmental impacts of continued operation and the no-action alternative were predicted to be SMALL in all areas. The impacts of alternatives were predicted to have impacts in some environmental aspects that could reach MODERATE or LARGE significance.

After the formal presentations were given by the NRC staff, members of the public were invited to provide comments. Approximately 100 people attended the two sessions. Attendees included members of the public, representatives of the NRC, representatives of state and local government, non-profit organizations, Exelon, AmerGen, and the news media.

In an effort to improve communication and increase interaction with members of the public, the NRC staff conducted an open house for one hour before each meeting and encouraged the public to submit meeting feedback forms. The staff provided displays and brochures and met with members of the public to answer questions about the proposed renewal of the Oyster Creek operating license.

A combined listing of attendees for both sessions is provided in Enclosure 1. Enclosure 2 is a copy of the meeting handouts. Enclosures 3 and 4 contain the official corrected transcripts for the afternoon and evening meetings, respectively. Enclosure 5 contains a copy of the slides used during the NRC's presentation.

The closing date to accept comments on the Oyster Creek DSEIS is September 8, 2006. The NRC staff will consider all comments on the Oyster Creek DSEIS and make any necessary revisions to the document prior to issuing its final supplemental environmental impact statement, scheduled for January 2007.

FOR

Michael Masnik, Environmental Project Manager
Environmental Branch B
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket No. 50-219

Enclosures:
As stated

cc w/encls: See next page

LIST OF ATTENDEES
OYSTER CREEK DRAFT SUPPLEMENTAL
ENVIRONMENTAL IMPACT STATEMENT PUBLIC MEETINGS

JULY 12, 2005

ATTENDEES	AFFILIATION
Donnie Ashley	U.S. Nuclear Regulatory Commission (NRC)
Dennis Beissel	NRC
Eric Benner	NRC
Chip Cameron	NRC
Derrick Dease	NRC
Marc Ferdas	NRC
Briana Harris	NRC
Frank Gillespie	NRC
Chris Jacobs	NRC
Evan Keto	NRC
Sarah Lopas	NRC
Jessie Muir	NRC
Michael Masnik	NRC
Harriet Nash	NRC
Bob Palla	NRC
Bo Pham	NRC
Neil Sheehan	NRC
Ryan Treadway	NRC
Scott Werts	NRC
Kevin Williams	NRC
Mitzi Young	NRC
Kirk LaGory	Argonne National Laboratory (ANL)
Mike Lazzarro	ANL
Jeff Ward	Pacific Northwest National Laboratory
Tom Allison, Jr.	Allison Systems Corp.
Nick Clunn	Asbury Park Press
Tim Delaugh	ARS
Jeanine Cara	Barnegat Bay NEP
Keith Rella	Clean Ocean Action
Cindy Zipf	Clean Ocean Action
Jim Knubel	Contractor
Brian Hasemann	Department of Homeland Security, Region II, NY
Paul Daley	Dover Township Police, OEM
David Sims	Ecological Systems
Jane R. DeMarzo	Grammies
Donald Warren	ISNW
Edith Gbur	Jersey Shore Nuclear Watch
Bob Vosseller	Lacey Beacon
Jack Nosti	Lacey Township
David Most	Lacey Township Committee
Babara Bailine	League of Women Voters

LIST OF ATTENDEES
OYSTER CREEK DRAFT SUPPLEMENTAL
ENVIRONMENTAL IMPACT STATEMENT PUBLIC MEETINGS (Cont'd)

JULY 12, 2005

ATTENDEES	AFFILIATION
John K. Ruben	League of Women Voters
Gail Marsh Saxer	League of Women Voters of Ocean County
Kevin Commons	L.U. 1289 (IBEW)
Ed Stoup	L.U. 1289 (IBEW)
Gina Talluto	L.U. 1289 (IBEW)
Kathryn M. Sutton	Morgan Lewis
Paul Gunter	NIRS
Tom Kolesnik	NJDEP
Heather Genievich	NJDEP
Regina Russel	NJDEP
Susan Rosenwinkel	NJDEP
Karen Tucillo	NJDEP
Dennis Zannoni	NJDEP
Rich Pinney	NJDEP/BNE
Paul E. Schwartz	NJDEP/BNE
Tony Agliata	Ocean County Government
Robert J. Ingenito	Ocean County Health Department
David McKeon	Ocean County Planning
Mark Villinger	Ocean County Planning
Jennifer Sneed	Office of US Sen. Frank R. Lautenberg
Zach Patberg	Press of AC
Julie Hans	Progress Energy
Joseph Mangano	Radiation & Public Health Project
Michael Kennish	Rutgers
William deCamp Jr.	Save Barnegat Bay
Grace Musumeci	USEPA Region 2
Caroline Heinle	WOBM
Dave Polaski	WOBM/Millennium Radio
Arthur J. Anderson	Resident
Gladys H. Anderson	Resident
Mrs. Borowski	Resident
Andrew A. Brown	Resident
Eugene Creamer	Resident
Veronica DiChiara	Resident
Joan Finn	Resident
David Hanna	Resident
Ryan Horrath	Resident
John T. Jolly	Resident
Ruth Metz	Resident
Ann Miles	Resident
Lynette Renda	Resident

LIST OF ATTENDEES
OYSTER CREEK DRAFT SUPPLEMENTAL
ENVIRONMENTAL IMPACT STATEMENT PUBLIC MEETINGS (Cont'd)

JULY 12, 2005

ATTENDEES	AFFILIATION
Wayne Romberg	Resident
Isadoro Rubin	Resident
Edward A. Schilling	Resident
Cathy Sims	Resident
Chris Trayon	Resident
Roberto Weinmann	Resident
Rachelle Benson	Oyster Creek Nuclear Generating Station (OCNGS)
Neva Fox	OCNGS
Kim Hochrun	OCNGS
Dean Iverjen	OCNGS
Jennifer Nelson	OCNGS
Carl Roth	OCNGS
John Ruffo	OCNGS
John Rayment	AmerGen/IBEW Local 1289
John Renda	AmerGen
Earl Beglin	Exelon
Nina Beglin	Exelon
Gilbert DeVries	Exelon
Mike Gallagher	Exelon
Gina Guerrazzi	Exelon
John Hufnagel	Exelon
Jim Laird	Exelon
Bill Maher	Exelon
John O'Rourke	Exelon
Tom Prosm	Exelon
Tim Rausch	Exelon
Howie Ray	Exelon
Tracy J. Siglin	Exelon
Chris Wilson	Exelon
Dave Woods	Exelon

AGENDA FOR PUBLIC MEETINGS TO DISCUSS THE DRAFT SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT FOR THE LICENSE RENEWAL OF OYSTER CREEK NUCLEAR GENERATING STATION

JULY 12, 2006

Two Identical Sessions - 1:30 p.m. to 4:30 p.m. and 7:00 p.m. to 10:00 p.m.*

I. Welcome and Purpose of Meeting	10 minutes (F. Cameron)
II. Overview of License Renewal Process	10 minutes (M. Masnik)
III. Results of the Environmental Review	30 minutes (K. LaGory)
IV. How Comments can be Submitted	5 minutes (M. Masnik)
V. Public Comments	2 hours
VI. Closing/Availability of Transcripts, etc.	5 minutes (F. Cameron)

*The NRC staff will host informal discussions one hour prior to each meeting session. No formal comments on the Draft Supplemental Environmental Impact Statement (DSEIS) will be accepted during the informal discussions. To be considered, comments must be provided either at the transcribed public meetings (see agenda, above) or in writing, as described in the attached *Federal Register* notice.

Enclosure 2

Welcome to the NRC's Open House Associated with the Environmental Review for the proposed License Renewal of Oyster Creek Nuclear Generating Station

This open house is intended to provide an opportunity for interested members of the public and staff from other Federal, State, and local agencies to interact with the NRC staff in an informal information exchange.

The NRC is gathering information necessary to prepare an Supplemental Environmental Impact Statement (SEIS) to the Generic Environmental Impact Statement (GEIS) for License Renewal of Nuclear Plants, regarding the proposed renewal of the operating licenses for Oyster Creek Nuclear Generating Station. Please note that if you wish to provide formal comments regarding the draft Supplemental Environmental Impact Statement (DSEIS) to the GEIS, they must be presented at today's transcribed public meeting, or provided in writing or by e-mail by September 8, 2006. Comments received after this date will be considered if it is practicable to do so, but the NRC staff is able to assure consideration only for comments received on or before this date. Written comments on the DSEIS should be sent to:

Chief, Rules and Directives Branch
Division of Administrative Services
Office of Administration
Mailstop T-6D 59
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

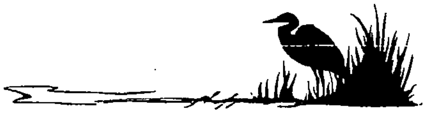
Comments may be hand-delivered to the NRC at 11545 Rockville Pike, Rockville, Maryland, between 7:45 a.m. and 4:15 p.m. on Federal workdays. Submittal of electronic comments may be sent by e-mail to the NRC at OysterCreekEIS@nrc.gov.

Thank you for your participation.

Preliminary Results of Environmental Review Oyster Creek Nuclear Generating Station

U.S. Nuclear Regulatory Commission

July 12, 2006



Purpose of Today's Meeting

- Discuss NRC's license renewal process
- Describe the environmental review
- Discuss the results of our review
- Provide the review schedule
- Accept any comments you may have today
- Describe how to submit comments

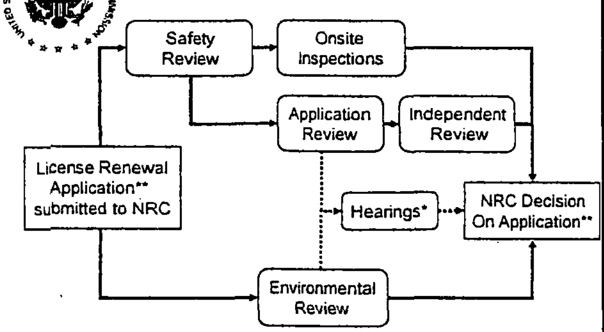
NRC's Regulatory Oversight

- Atomic Energy Act
  - Issue operating licenses
  - Regulate civilian use of nuclear materials
- NRC's Mission
  - Public health and safety
  - Promote common defense and security
  - Protect the environment

Oyster Creek Nuclear Generating Station License Renewal

- Operating license expires April 9, 2009
- Application requests authorization to operate Oyster Creek for an additional 20 years.

License Renewal Process



* If a Request for Hearing is Granted

** Available at www.nrc.gov

Scope of License Renewal Safety Review

- Limited to aging management
  - Systems, structures and components important to safety
  - Determined by license renewal scoping criteria
- Current issues that are out of scope
  - Security
  - Emergency Planning
  - Safety Performance

Safety Review Process

- Safety evaluation
  - Audits
  - Evaluation of technical information
- Plant inspections
- Independent review
  - Advisory Committee on Reactor Safeguards (ACRS)

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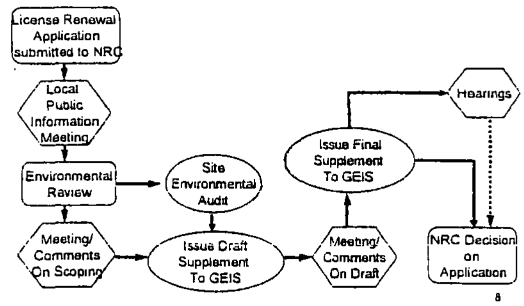
Environmental Review Process



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National Environmental Policy Act (NEPA)

- NEPA requires Federal agencies to use a systematic approach to consider environmental impacts.
- An Environmental Impact Statement (EIS) is required for major Federal actions significantly affecting the quality of the human environment.
- Commission has determined that a supplement to the "Generic EIS for License Renewal of Nuclear Plants" will be prepared for a license renewal application.

9

Decision Standard for Environmental Review

To determine whether or not the adverse environmental impacts of license renewal for Oyster Creek Nuclear Generating Station are so great that preserving the option of license renewal for energy planning decisionmakers would be unreasonable.

10

Environmental Review Milestones

Application Received	**July 22, 2005**
Notice of Intent	**September 16, 2005**
Scoping Public Meetings	**November 1, 2005**
Scoping Period Ended	**November 25, 2005**
Draft SEIS Issued	**June 9, 2006**
Draft SEIS Public Meetings	**July 12, 2006**
Draft SEIS Comments Due	**September 8, 2006**
Final SEIS Issued	**January 2007**

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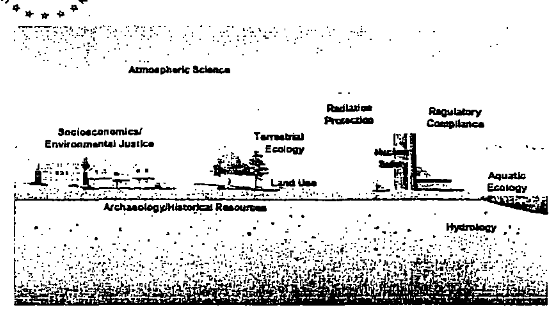
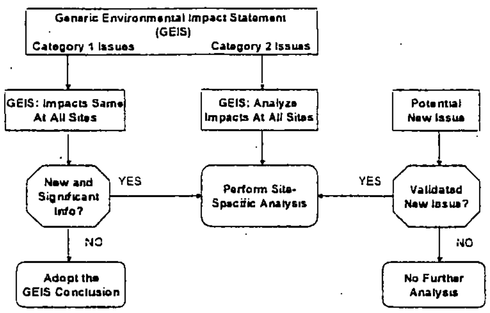
Team Expertise



12

Analytical Approach



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How Impacts are Quantified

- NRC-defined impact levels:
  - SMALL: *Effect is not detectable or too small to destabilize or noticeably alter any important attribute of the resource*
  - MODERATE: *Effect is sufficient to alter noticeably, but not destabilize, important attributes of the resource*
  - LARGE: *Effect is clearly noticeable and sufficient to destabilize important attributes of the resource*
- Consistent with the Council on Environmental Quality guidance for NEPA analyses

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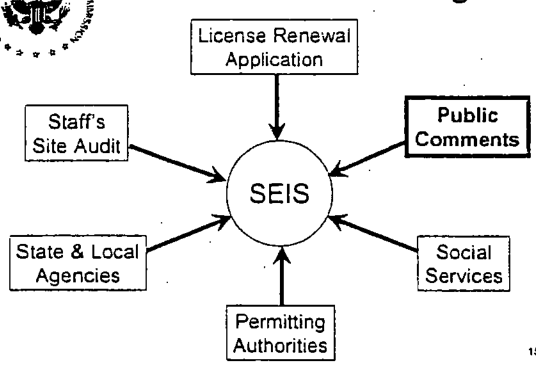
Information Gathering



15

Environmental Impacts of Continued Operation

- Cooling system
- Transmission line
- Radiological
- Socioeconomics
- Groundwater use and quality
- Threatened or endangered species
- Cumulative impacts
- Accidents

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Cooling System Impacts

- Category 2 issues
  - Entrainment of fish and shellfish in early life stages
  - Impingement of fish and shellfish
  - Heat shock
- Preliminary findings
  - Impacts would be SMALL

17

Radiological Impacts

- Category 1 issues
  - Radiation exposures to the public
  - Occupational radiation exposures
- Preliminary findings
  - No new and significant information identified
  - GEIS concluded impacts would be SMALL

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Threatened or Endangered Species

- Threatened or endangered species in the vicinity include five species of sea turtles and the bald eagle
- 2005 Biological Opinion for sea turtle establishes incidental take limits
- No impacts expected to bald eagle
- Impacts would be SMALL

19

Cumulative Impacts of Operation

- Impacts of renewal term operations combined with other past, present, and reasonably foreseeable future actions
  - Evaluated to end of 20-year renewal term
  - Geographic boundaries dependent on resource
- Cumulative impacts would be SMALL

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Other Environmental Impacts Evaluated

- Uranium fuel cycle and solid waste management
- Decommissioning

21

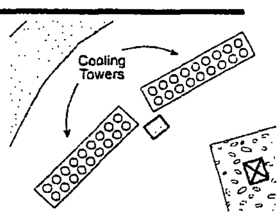
Alternatives to License Renewal

- No-action
- Alternative energy sources
  - New generation (coal, natural gas, nuclear)
  - Purchased electrical power
  - Other alternatives (oil, wind, solar, conservation)
  - Combination of alternatives
- Environmental effects of alternatives, in at least some impact categories, reach MODERATE or LARGE significance

22

Cooling System Alternatives

- Closed-cycle cooling using hybrid mechanical draft cooling towers
- Modification of existing once-through system with wetland restoration
- Most impacts would be SMALL except closed-cycle system could have MODERATE impacts on air quality



23

Preliminary Conclusions

- GEIS conclusions on Category 1 issues adopted
- Impacts resulting from Category 2 issues would be of SMALL significance
- Environmental effects of alternatives may reach MODERATE or LARGE significance

24

Postulated Accidents

- Design-basis accidents
- Severe accidents
  - Severe accident mitigation alternatives (SAMAs)

25

Preliminary Results of SAMA Evaluation

- 136 potential SAMAs considered
- Number of SAMAs reduced to 37 based on screening process
- Detailed cost-benefit analysis shows that 15 SAMAs could be cost beneficial
- None are required to be implemented as part of license renewal

26

Preliminary Conclusions

- Impacts of license renewal would be SMALL for all impact areas.
- Impacts of alternatives may reach MODERATE to LARGE.
- The staff's preliminary recommendation is that the adverse environmental impacts of license renewal for Oyster Creek Nuclear Generating Station are not so great that preserving the option of license renewal for energy planning decisionmakers would be unreasonable.

27

Environmental Review Milestones

- Draft SEIS issued – **June 9, 2006**
- Comment period ends – **September 8, 2006**
- Issuance of Final SEIS – **January 2007**

28

Additional Information

- NRC contact: Dr. Michael T. Masnik (800) 368-5642, Ext. 1191
- Documents located at the Lacey Township Library (10 East Lacey Road, Forked River, New Jersey 08731)
- Draft SEIS can also be viewed at: www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1437/supplement28/

29

Submitting Comments

- By mail: Chief, Rules and Directives Branch
  Division of Administrative Services
  Mailstop T-6D59
  U.S. Nuclear Regulatory Commission
  Washington DC 20555
- In person: 11545 Rockville Pike
  Rockville, Maryland
- By e-mail: OysterCreekEIS@nrc.gov

30

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

+ + + + +

PUBLIC MEETING TO DISCUSS THE DRAFT SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT FOR THE LICENSE RENEWAL OF OYSTER CREEK NUCLEAR GENERATING STATION

+ + + + +

WEDNESDAY,

JULY 12, 2006

+ + + + +

The meeting convened at 1:30 p.m. in the Grand Ballroom of the Toms River Quality Inn, 815 Route 37, Toms River, New Jersey, CHIP CAMERON, Special Counsel for Public Liaison, Nuclear Regulatory Commission, presiding.

I-N-D-E-X

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
NORTHEAST REGION
One Blackburn Drive
Gloucester, MA 01930-2298

OCT 18 2006

Frank Gillespie, Director
Division of License Renewal
Office of Nuclear Reactor Program
United States Nuclear Regulatory Commission
Washington, DC 20555-0001

Dear Mr. Gillespie,

On June 9, 2006, NOAA's National Marine Fisheries Service (NMFS) entered into formal Section 7 consultation on the US Nuclear Regulatory Commission's (NRC) proposed renewal of the operating license for the Oyster Creek Nuclear Generating Station (OCNGS). The facility's current license expires on April 9, 2009 and the NRC proposes to renew the license for an additional 20 years. The 135-day consultation period expires on October 28, 2006.

As you may know, NMFS staff met with NRC staff and the applicant (AmerGen Energy, LLC) on September 19, 2006 at OCNGS. In order to incorporate information obtained at this meeting into the ongoing consultation, NMFS has requested an additional 30 days to complete the consultation. This would result in a Biological Opinion being issued to NRC by November 27, 2006. At the September 19, 2006 meeting, Harriet Nash of your staff and Malcolm Browne of AmerGen concurred with the need to extend the consultation period.

If you have any questions or concerns about this extension or the consultation process in general, please contact Julie Crocker of my staff at (978)281-9300 ext. 6530. We look forward to continuing to work with your office during the formal consultation process.

Sincerely,

for Patricia A. Kurkul
Regional Administrator

cc: Harriet Nash, NRC
Malcolm Browne, AmerGen
Williams, GCNE

File Code: Section 7 NRC New Jersey – Oyster Creek NGS 2006 consultation
PCTS: F/NER/2006/05114

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

November 15, 2006

Ms. Patricia Kurkul
Regional Administrator
National Marine Fisheries Service
Northeast Region
One Blackburn Drive
Gloucester, MA 01930-2298

SUBJECT: EXTENSION FOR THE BIOLOGICAL OPINION FOR THE OYSTER CREEK NUCLEAR GENERATING STATION

Dear Ms. Kurkul:

The U.S. Nuclear Regulatory Commission (NRC) has received your letter, dated October 18, 2006, requesting an extension for the Biological Opinion regarding continued operation of the Oyster Creek Nuclear Generating Station. On June 9, 2006, the NRC and the National Marine Fisheries Service entered a formal consultation under Section 7 of the Endangered Species Act of 1973, as amended, on the possible effects of continued operation of the Oyster Creek Nuclear Generating Station.

We accept the requested extension and look forward to receiving your Biological Opinion by November 27, 2006. If you have any questions or require additional information, please contact Ms. Harriet Nash at 301-415-4100 or hln@nrc.gov.

Sincerely,

/for

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

Docket No. 50-219

cc: See next page

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Oyster Creek Nuclear Generating Station

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Mr. Christopher M. Crane
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UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
NORTHEAST REGION
One Blackburn Drive
Gloucester, MA 01930-2298

NOV 2 1 2006

Frank Gillespie, Director
Division of License Renewal
Office of Nuclear Reactor Program
United States Nuclear Regulatory Commission
Washington, DC 20555-0001

Re: Oyster Creek Nuclear Generating Station

Dear Mr. Gillespie,

Enclosed is NOAA's National Marine Fisheries Service's (NMFS) Biological Opinion (Opinion) on the impacts on endangered and threatened species of the Nuclear Regulatory Commission's proposal to renew the Operating License for the Oyster Creek Nuclear Generating Station (OCNGS) for an additional twenty years. This Opinion is based upon NMFS independent review of information submitted by the NRC, available information on past takes of sea turtles at the facility and the available scientific information. In this Opinion, NMFS concludes that the continued operation of the OCNGS under a renewed Operating License may adversely affect but is not likely to jeopardize the continued existence of endangered Kemp's ridley, green, or threatened loggerhead sea turtles. NMFS has concluded that the action will not affect leatherback or hawksbill sea turtles as these species are not known to occur in the action area for this consultation.

The Incidental Take Statement (ITS), pursuant to Section 7 (b)(4) of the ESA, exempts the annual take of up to 8 sea turtles at the facility each year. NMFS anticipates that of these 8 sea turtles, no more than 3 of these turtles are likely to be loggerheads and no more than 1 of these sea turtles are likely to be a green sea turtle. NMFS anticipates that up to 3 of the 8 sea turtles may be dead; of the dead sea turtles, no more than 1 is likely to be a green sea turtle and no more than 1 is likely to be a loggerhead. The ITS specifies reasonable and prudent measures necessary to minimize and monitor take of listed species, including requiring the transfer of all sea turtles to a NMFS approved rehabilitation facility. The measures of the ITS are non-discretionary and must be undertaken by NRC for the incidental take exemption to apply.

This Opinion concludes formal consultation for the continued operation of the OCNGS. Reinitiation of this consultation is required if: (1) the amount or extent of taking specified in the ITS is exceeded; (2) new information reveals effects of these actions that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) project activities are subsequently modified in a manner that causes an effect to the listed species that was not considered in this Biological Opinion; or (4) a new species is listed or critical habitat designated that may be affected by the identified action. NMFS will consider the take level to be

exceeded, and reinitiation of consultation necessary, when *any* of the following situations occur in one calendar year:

- Capture of more than 1 green sea turtle (dead or alive); or,
- Capture of more than 3 live loggerhead sea turtles; or,
- Capture of more than 1 dead loggerhead sea turtle; or,
- Capture of more than 3 dead Kemp's ridley sea turtles; or,
- Capture of more than 8 total sea turtles.

As identified in the Opinion, NMFS Northeast Regional staff must be contacted within 24 hours of any interactions with a sea turtle.

It is NMFS understanding that OCNGS will operate under its current license until April 9, 2009. At the time NRC renews the license for OCNGS, NMFS will consider the September 22, 2005 Biological Opinion and ITS withdrawn and this Biological Opinion and ITS will become effective. Should you have any questions regarding this Biological Opinion or any consultation requirements, please contact Julie Crocker of my staff at (978)281-9300 x6530 or the Endangered Species Coordinator at (978) 281-9328. NMFS appreciates your assistance with the protection of threatened and endangered sea turtles. I look forward to continued cooperation with NRC during future Section 7 consultations.

Sincerely,

for Patricia A. Kurkul
Regional Administrator

cc: H. Nash, NRC
M. Browne, AmerGen
Williams, GCNE

File code: Section 7 NRC – Oyster Creek 2006
PCTS: F/NER/2006/05114

ENDANGERED SPECIES ACT SECTION 7 CONSULTATION
BIOLOGICAL OPINION

Agency: Nuclear Regulatory Commission

Activity: Proposed Renewal of an Operating License for the Creek Nuclear Generating Station on the Forked River and Oyster Creek, Barnegat Bay, New Jersey
PCTS: I/NER/2006/05114

Conducted by: NOAA's National Marine Fisheries Service
Northeast Regional Office

Date Issued: 11/22/06

Approved by: [signature] for Patricia Kurkul

INTRODUCTION

This constitutes NOAA's National Marine Fisheries Service's (NMFS) biological opinion (Opinion) on the effects of the Nuclear Regulatory Commission's (NRC) proposed renewal of an Operating License pursuant to the Atomic Energy Act of 1954 as amended (68 Stat. 919) and Title II of the Energy Reorganization Act of 1974 (88 Stat. 1242) for the continued operation of the Oyster Creek Nuclear Generating Station (OCNGS) on threatened and endangered species in accordance with section 7 of the Endangered Species Act of 1973, as amended. Consultation was initiated on June 15, 2006.

This Opinion is based on information provided in the June 2006 Environmental Impact Statement, a March 29, 2005 Biological Assessment (BA), records from previous section 7 consultations on the operation of this facility and correspondence with Ms. Harriet Nash, NRC, and Mr. Malcolm Browne, AmerGen Energy Company, and other sources of information. A complete administrative record of this consultation will be kept on file at the NMFS Northeast Regional Office, Gloucester, Massachusetts.

BACKGROUND AND CONSULTATION HISTORY

The OCNGS began commercial operation in 1969. No observed takes of endangered or threatened species occurred at the OCNGS prior to 1992. However, between June 1992 and July 1994, 9 sea turtle impingements occurred at the OCNGS intake trash bars, including 5 loggerheads (4 individuals, 1 recapture), and 4 Kemp's ridleys (see Figures 1 and 2 and complete information in Appendix 1). In a letter dated November 2, 1993, NMFS stated that formal consultation on the operation of the OCNGS was necessary due to takes of threatened and endangered sea turtles. In a letter dated November 19, 1993, the NRC requested formal consultation. A BA was prepared by the OCNGS, reviewed and submitted by the NRC, and received by NMFS on January 25, 1995.

A Biological Opinion (Opinion) on the effects of the operation of OCNGS on loggerhead, green, and Kemp's ridley sea turtles was signed on September 21, 1995. This Opinion concluded that the continued operation of this station may adversely affect listed turtles, but is not likely to jeopardize their continued existence. The accompanying Incidental Take Statement (ITS) exempted the annual take of 10 loggerhead (no more than 3 lethal), 3 Kemp's ridley (no more than 1 lethal), and 2 green (no more than 1 lethal) sea turtles. The incidental take exemption extended for a period of 5 years from the date of the Opinion (i.e., to September 21, 2000).

Between 1995 and 2000, there were nine takes of sea turtles associated with the OCNGS. Although no sea turtles were taken in 1995 or 1996, the level of incidental take exempted in the 1995 Opinion was met during three of these years: in 1997 with the lethal take of a Kemp's ridley turtle, in 1999 with the lethal take of a green turtle, and again in 2000 with the lethal take of a Kemp's ridley turtle. However, these takes did not trigger reinitiation of formal consultation on OCNGS as Section 7 consultation must be reinitiated if "the amount or extent of taking specified in the incidental take statement is *exceeded*" (50 CFR 402.16).

On August 3, 2000, NMFS was copied on a letter from the Acting Site Director of the OCNGS, Sander Levin, to the NRC, requesting the renewal of the Biological Opinion/Incidental Take Statement and submitting an updated BA. In a telephone conversation on August 24, 2000, NRC informed NMFS that they would be sending a letter requesting reinitiation of formal consultation. On September 18, 2000, four days before the previous incidental take statement was to expire, NRC requested reinitiation of formal consultation on the effects of the continued operation of the OCNGS on sea turtles and submitted a revised BA. In a letter dated October 6, 2000, NMFS acknowledged the receipt of the formal consultation request and the BA. At that time, NMFS requested additional information before formal consultation could proceed.

During a telephone discussion in December 2000, NRC and AmerGen staff informed NMFS that information was not available for several items requested in NMFS' October 6 letter (e.g., updated necropsy information). On January 23, 2001, the NRC submitted supplemental information and clarification on the BA as requested by NMFS. NRC also identified areas where data were lacking or unavailable. Consultation was completed with the issuance of an Opinion dated July 18, 2001. The accompanying ITS exempted the annual take of 5 loggerheads (no more than 3 lethal), 4 Kemp's ridley (no more than 3 lethal), and 2 green (no more than 1 lethal) sea turtles. A revised ITS was issued on August 29, 2001 in response to concerns raised by the AmerGen Energy Company in regards to some requirements in the terms and conditions; however, no changes were made to the numbers of exempted sea turtle takes.

On August 7, 2004, the OCNGS recorded its fifth incidental take of a Kemp's ridley sea turtle since the beginning of the year, exceeding the incidental take statement for the facility. This incidental take was followed by 3 more takes of Kemp's ridley sea turtles on September 11, September 12, and September 23, 2004 respectively. The amount of taking exempted by the ITS was exceeded, and in a letter dated August 26, 2004 NRC requested reinitiation of formal section 7 consultation for the continued operation of OCNGS. On April 28, 2005 NMFS received a BA, dated March 29, 2005 from the NRC.

On June 3, 2005 NMFS informed NRC that all the information necessary for a formal section 7 consultation and the preparation of a Biological Opinion had been received and reminded NRC that they were prohibited from making any irreversible or irretrievable commitments of resources that would prevent NMFS from proposing or the NRC from implementing any reasonable and prudent alternatives to avoid jeopardizing sea turtles. Also in this letter, NMFS recommended that the NRC continue to implement the requirements identified in the July 18, 2001 Opinion until consultation was concluded. During the consultation period, 2 Kemp's ridley sea turtles were impinged at the OCNGS.

Section 7 consultation concluded with the issuance of an Opinion dated September 22, 2005. This Opinion analyzed the effect of the continued operation of the OCNGS through the expiration of the current NRC license (April 2009). In this Opinion, NMFS concluded that the continued operation of the OCGNS was likely to adversely affect but not likely to jeopardize the continued existence of loggerhead, Kemp's ridley or green sea turtles. The ITS accompanying the 2005 Opinion exempted the annual take of 2 loggerheads (1 lethal), 8 Kemp's ridleys (4 lethal), and 1 green (alive or dead) annually as a result of the operation of the OCNGS.

In a letter dated June 9, 2006, NRC requested the initiation of Section 7 consultation on the effects of the operation of the OCNGS under a renewed NRC license. In this letter, NRC made the preliminary determination that the renewal of the Operating License would result in adverse effects to loggerhead, Kemp's ridley and green sea turtles. As noted above, the current NRC license expires on April 9, 2009. NRC is currently proposing to extend the term of the license for an additional 20 years, with the license expiring on April 9, 2029. In a letter dated July 7, 2006, NMFS informed NRC that all the information necessary for consultation had been received and that the date the June 9 letter had been received (June 15, 2006) would serve as the date of initiation of formal consultation. On September 19, 2006 a meeting was held at the OCNGS between AmerGen staff, New Jersey Department of Environmental Protection, NMFS and NRC. As a result of the need to incorporate information from that meeting into the Opinion being drafted, the consultation period was extended for 30 days. It should also be noted that during the consultation period, 6 sea turtles were impinged at the OCGNS (4 Kemp's ridleys (1 dead) and 2 live loggerheads). See Figures 1-3 for an illustration of the total number of sea turtles taken at OCNGS between 1992 and 2006.

	Kemp's ridley	Loggerhead	Green	**TOTAL**
1992	1	3*	0	**4**
1993	1	0	0	**1**
1994	2	2	0	**4**
1995	0	0	0	**0**
1996	0	0	0	**0**
1997	1	0	0	**1**
1998	0	1	0	**1**
1999	1	0	1	**2**
2000	2	2	1	**5**
2001	2	0	1	**3**
2002	2	0	0	**2**
2003	1	0	1	**2**
2004	8	0	0	**8**
2005	2	0	0	**2**
2006	4	2	0	**6**
TOTAL	**27**	**10**	**4**	**41**

Figure 1. Total number of sea turtles captured or impinged at OCNGS from 1992 – 2006. *Two individual loggerheads were captured in 1992; one was recaptured two days following release into the discharge canal.

Figure 2. Total (live and dead) number of sea turtles impinged or captured at OCNGS, 1992 - 2006.

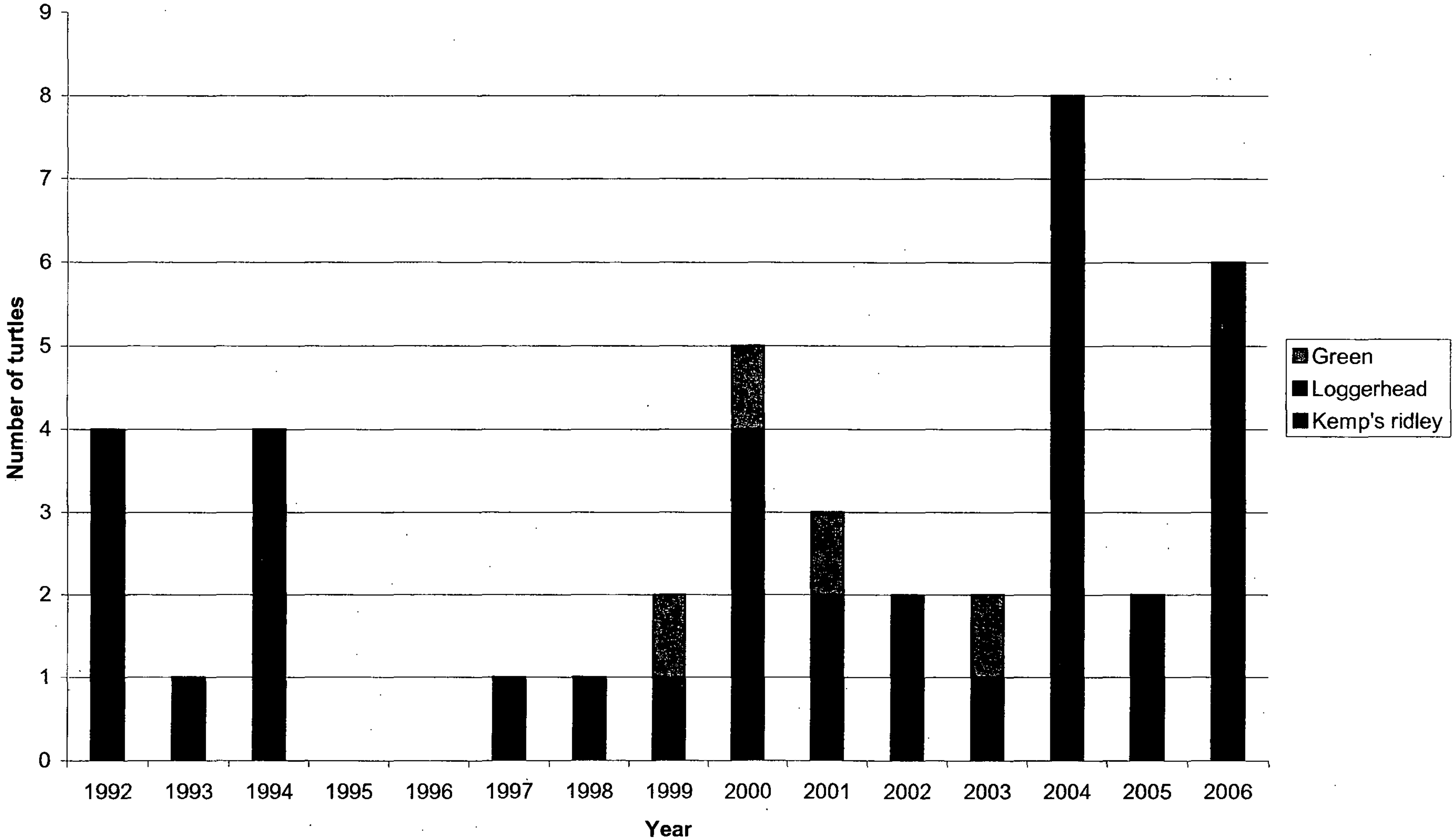


Figure 3. Number of dead sea turtles impinged at OCNGGS from 1992-2006

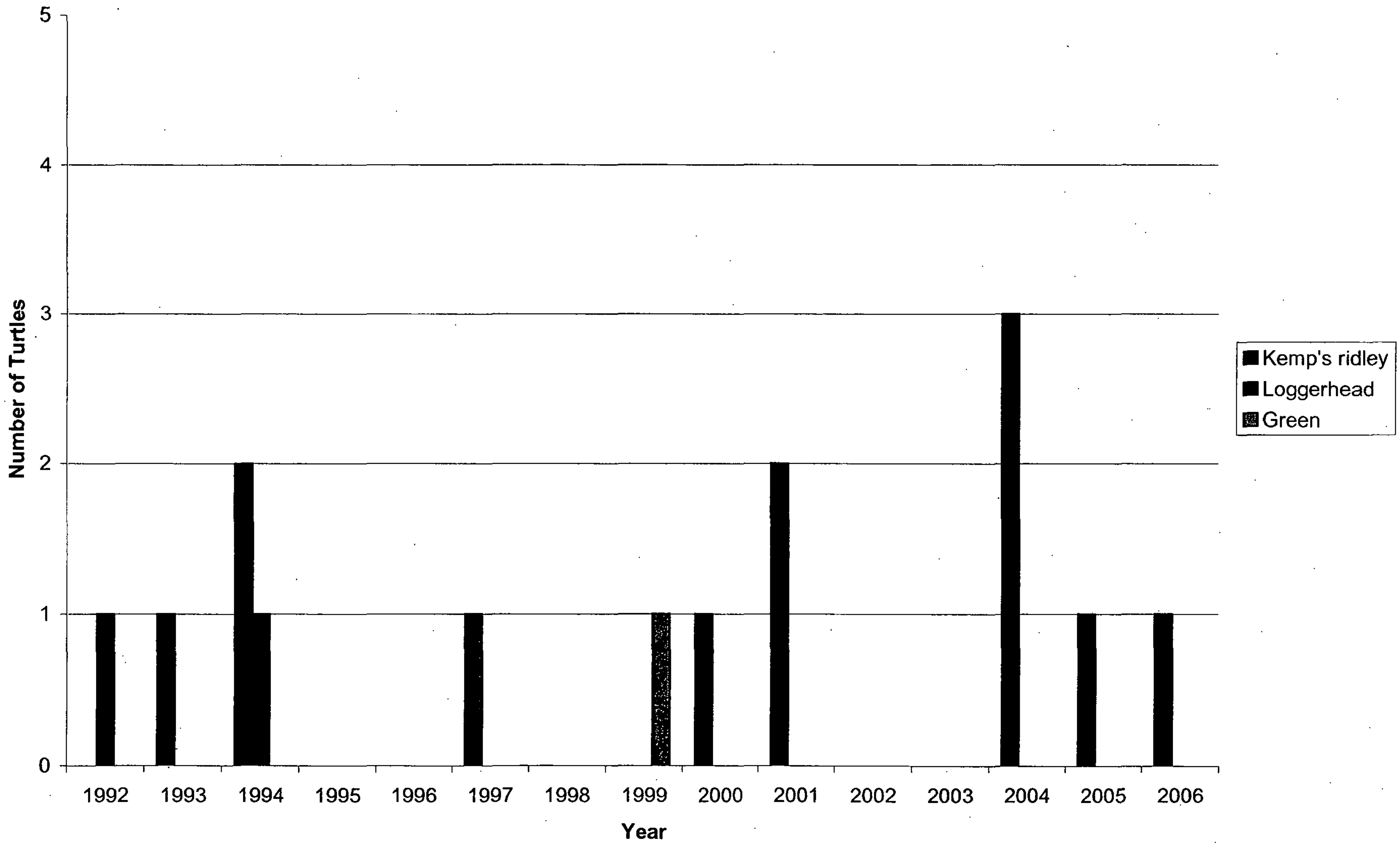
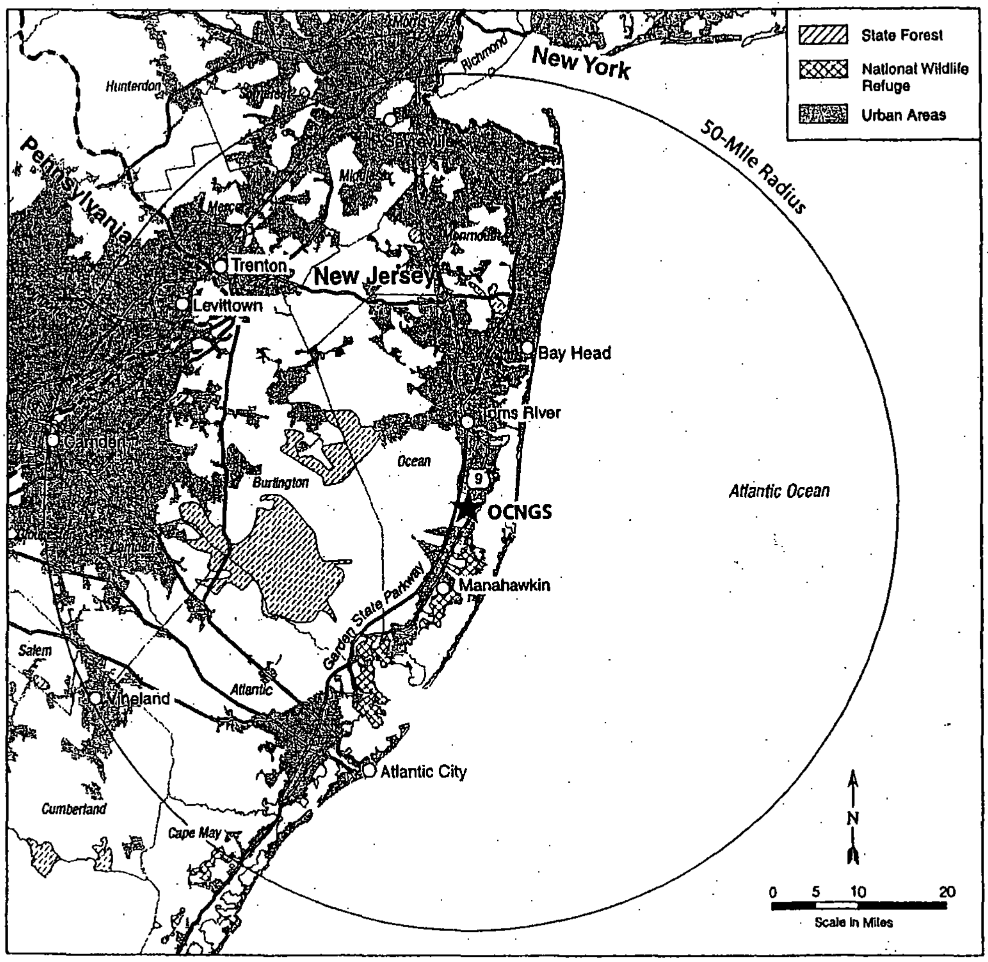
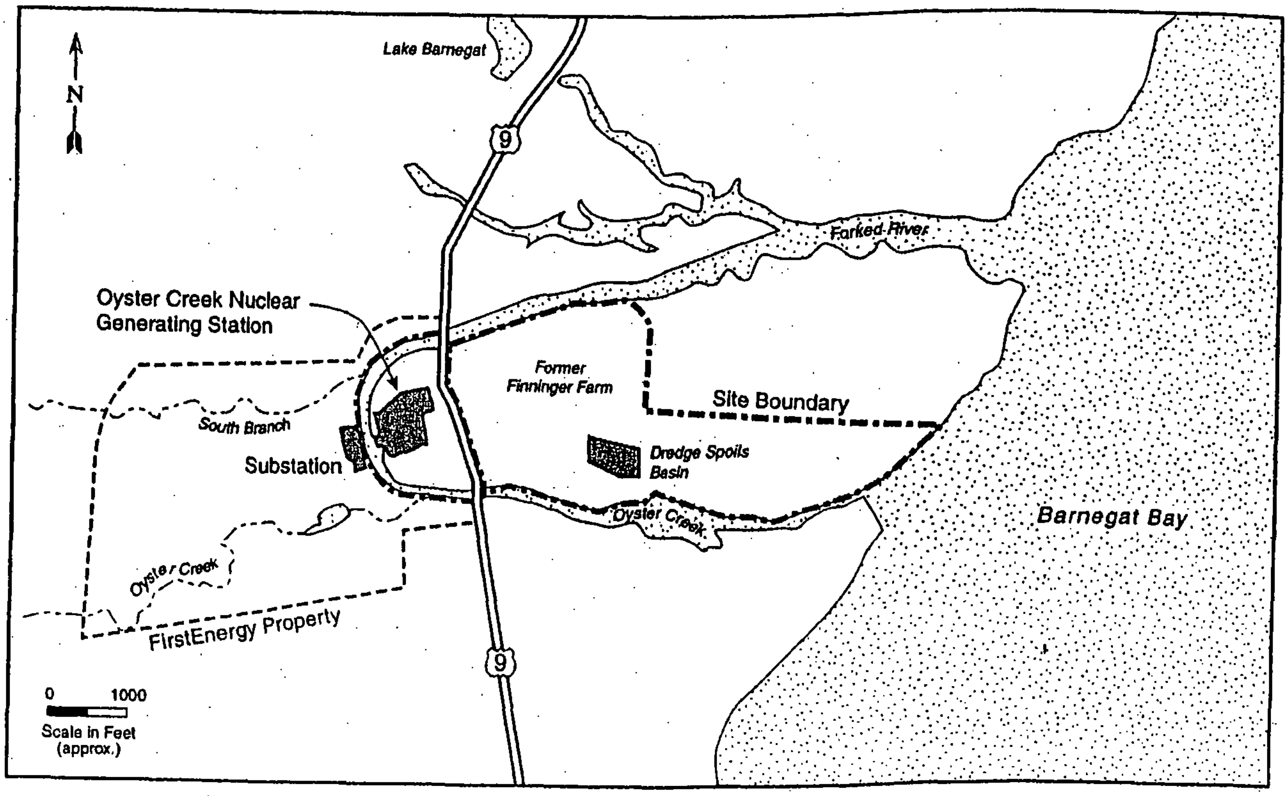


Figure 4. Location of OCNGS.





DESCRIPTION OF THE PROPOSED ACTION

The proposed activity is the continued operation of the Oyster Creek Nuclear Generating Station under the terms of a renewed license. NRC proposes to renew the OCGNS operating license for a period of an additional 20 years (through April 2029). The current NRC license was issued on April 9, 1989 and expires on April 9, 2009.

The OCNGS facility is located in Lacey Township, New Jersey and lies between the south branch of the Forked River and Oyster Creek. Both streams discharge into Barnegat Bay. The facility was constructed in the 1960s and became operational in December 1969. During construction, a semicircular canal was dredged between the two streams to create a horseshoe shaped cooling water system that consists of the lower reaches or the south branch of the Forked River, the man-made dredged canal and the lower reaches of Oyster Creek (see Figure 4 for a map of the facility). The facility currently operates under a license issued by the NRC on April 9, 1989 which is set to expire on April 9, 2009. When the plant is operational, the flow direction in the south fork of the Forked River is reversed, and all of the flow goes into the OCNGS.

OCNGS is a single unit plant with a boiling water nuclear reactor and steam turbine. The reactor has a design power level of 1930 megawatts thermal and a net power output of 640 megawatts electric. Plant cooling is provided by a once through system that draws water from Barnegat Bay via the south branch of the Forked River and a man-made intake canal and discharges heat back to Barnegat Bay via a man-made discharge canal and Oyster Creek. Two separate intake structures withdraw water from the intake canal, the circulating water system intake (CWS) and the dilution water system (DWS) intake.

The CWS provides cooling water for the main condensers and for safety-related heat exchangers and other equipment within the station. Water is drawn into the CWS from the intake canal (south fork of the Forked River) through six intake bays and is subsequently discharged into the discharge canal as heated effluent. During normal plant operation, four circulating water pumps withdraw a total of 1740 m^3/min of water. The maximum permissible average intake velocity for water approaching the CWS intake ports is 30 cm/sec. The maximum daily effluent temperature for cooling water discharge back to the discharge canal is 41.1°C.

The DWS is designed to minimize the thermal effects on the discharge canal and Barnegat Bay by thermally diluting the circulating water from the condenser with colder ambient temperature water. Water is pumped from the intake canal through the six intake bays and discharged directly into the discharge canal, where it mixes with and reduces the temperature of the heated effluent from the CWS. A maximum of two dilution pumps are operated at one time, but when ambient water temperature exceeds 30.5°C, usually only one dilution pump is put into operation. The average intake velocity for water in front of the DWS intake (with two pumps in operation) is approximately 73 cm/sec. As expected, the average intake velocity with one DWS pump in operation is notably less than 73 cm/sec.

The dimensions and structures at the CWS are nearly identical to those of the DWS. Several differences are that the intake velocity at the DWS is much higher than at the CWS, and the CWS has a vertical traveling screen to filter small organisms. The intakes at both the CWS and

DWS are screened by six sets of trash bars, which extend from the bottom of each intake bay to several feet above the water (7.3 m high and 3.3 m wide). The depth at the intake bays are approximately 4 to 6 meters deep. The trash bars are 0.95 cm wide steel bars set on 7.5 cm centers, and the openings between the trash bars are 6.6 cm wide. A trash rake assembly traverses the entire width of the intake on rails; it contains a trash hopper which transports the material removed from the bars to a debris container. Personnel cleaning the CWS and DWS intake trash racks from June to October observe the trash rake during the cleaning operation so that the rake may be stopped if a sea turtle is sighted. The trash bars are inspected at least once every four hours (i.e., three times during each 12-hour work shift) from June to October to remove debris and to monitor potential sea turtle takes. At the CWS, organisms smaller than 6.6cm travel through the openings onto a traveling screen system where they are washed from the screens and returned to the discharge canal on a slide system. At the DWS, small organisms travel with the dilution water into the discharge canal.

A floating debris/ice barrier is in place upstream of the CWS and DWS intake structures to divert floating debris (e.g., wood, eelgrass, ice) away from the CWS intake and towards the DWS intake. The barrier is intended to prevent excessive amounts of debris or ice from accumulating on the CWS traveling screen or trash bars. The wood floating barrier extends 60 cm below the surface.

Both intakes have sea turtle retrieval/rescue equipment on site in the event of a sea turtle impingement. At the CWS intake structure, a rescue sling suitable for lifting large sea turtles (in excess of 20 kg) is present. Long-handled dip nets are present at the CWS and DWS intake structures during June through October, and are suitable for retrieving the smaller turtles which are more likely to be found at the OCNGS. Both the rescue sling and the long-handled dip nets are only adequate for retrieving turtles from the water surface or within about 1 meter of the surface, as the use of either device requires that the sea turtle be visible from the surface.

Action Area

The action area is defined in 50 CFR 402.02 as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." The direct and indirect effects of the OCNGS are the intake of water into the CWS and DWS from the south fork of the Forked River, which causes a reversal of normal flow, and the discharge of warmed and chlorinated water into Oyster Creek and Barnegat Bay. The discharge plume occupies Oyster Creek and extends into a relatively large surface area of Barnegat Bay (estimated to be less than 1.6 km in an east-west direction by 5.6 km in a north-south direction, under all conditions). In general, elevated temperatures do not extend to the bottom of the Bay except in the area immediately adjacent to the mouth of Oyster Creek.

Therefore, the action area for this consultation includes the intake areas of both the DWS and CWS intakes at the OCNGS, the south fork of Forked River, Oyster Creek, and the region where the thermal plume extends into Barnegat Bay from Oyster Creek.

LISTED SPECIES IN BARNEGAT BAY

Several species of listed sea turtles under NMFS' jurisdiction occur in New Jersey waters and are likely to occur in Barnegat Bay. These species include loggerhead, Kemp's ridley and green sea turtles. Hawksbill and leatherback sea turtles may also occur in New Jersey waters but, as explained below, these species are not likely to occur in the action area for this consultation.

Leatherback sea turtles are widely distributed throughout the oceans of the world, and are found in waters of the Atlantic, Pacific, Caribbean, and the Gulf of Mexico (Ernst and Barbour 1972). In the U.S. Atlantic Ocean, leatherback turtles are found in northeastern waters during the warmer months. This species is found in coastal waters of the continental shelf and near the Gulf Stream edge (Lutcavage 1996). Leatherbacks are predominantly a pelagic species and feed on jellyfish, cnidarians and tunicates; leatherbacks will travel to nearshore areas when in pursuit of these prey species.

Estimated to number approximately 115,000 adult females globally in 1980 (Pritchard 1982) and only 34,500 by 1995 (Spotila *et al.* 1996), leatherback populations have been decimated worldwide, not only by fishery related mortality but, at least historically, due to intense exploitation of eggs on the beach (Ross 1979). The status of the leatherback population in the Atlantic is difficult to assess since major nesting beaches occur over broad areas within tropical waters outside the United States. Recent information suggests that Western Atlantic populations declined from 18,800 nesting females in 1996 (Spotila et al., 1996) to 15,000 nesting females by 2000 (Spotila, pers. comm).

Leatherbacks have been documented in waters off New Jersey and have also been found stranded on New Jersey coastal and estuarine beaches. Shoop and Kenney (1992) observed concentrations of leatherbacks during the summer off the south shore of Long Island and off New Jersey. Leatherbacks in these waters are thought to be following their preferred jellyfish prey. This aerial survey estimated the leatherback population for the northeastern U.S. at approximately 300-600 animals (from near Nova Scotia, Canada to Cape Hatteras, North Carolina).

The only direct access to Barnegat Bay from the Atlantic Ocean is through a single, narrow inlet, approximately 300 m wide. While leatherbacks could enter Barnegat Bay, it is improbable given that this species is rarely found in inshore waters. Furthermore, given this species' distribution and migratory and foraging patterns, it is also unlikely that this species will travel through the navigation channels to reach the OCNGS. No leatherback sea turtles have been observed in Barnegat Bay or at OCNGS. As a result, NMFS has determined that leatherback sea turtles are not likely to occur in the action area for this consultation. As such, this species will not be considered further in this Opinion.

The *hawksbill sea turtle* is relatively uncommon in the waters of the continental United States. Hawksbills prefer coral reefs, such as those found in the Caribbean and Central America. Hawksbills feed primarily on a wide variety of sponges but also consume bryozoans, coelenterates, and mollusks. The Culebra Archipelago of Puerto Rico contains especially important foraging habitat for hawksbills. Nesting areas in the western North Atlantic include Puerto Rico and the Virgin Islands.

There are accounts of hawksbills in south Florida and a number are encountered in Texas each year. Most of the Texas records report small turtles, probably in the 1-2 year class range. Many of the captures or strandings that are reported are of individuals in an unhealthy or injured condition. The lack of sponge-covered reefs and the cold winters in the northern Gulf of Mexico probably prevent hawksbills from establishing a viable population in this area. In the north Atlantic, small hawksbills have stranded as far north as Cape Cod, Massachusetts. However, many of these strandings were observed after hurricanes or offshore storms. No takes of hawksbill sea turtles have been recorded in Northeast or mid-Atlantic fisheries covered by the Northeast Fisheries Science Center (NEFSC) observer program, but it should be noted that coverage has been limited in the past.

While hawksbills have occasionally been found in northern mid-Atlantic waters, it is improbable that this species will be present in the action area given its distribution, and migratory and foraging patterns. As a result, NMFS has determined that hawksbill sea turtles are not likely to occur in the action area for this consultation. As such, this species will not be considered further in this Opinion.

Species Likely To Occur in the Action Area
The following endangered or threatened species under NMFS' jurisdiction are likely to occur in the action area.

Sea Turtles

Loggerhead sea turtle (*Caretta caretta*)	Threatened
Green sea turtle[1] (*Chelonia mydas*)	Endangered[1]
Kemp's ridley sea turtle (*Lepidochelys kempi*)	Endangered

Loggerhead sea turtles
Loggerhead sea turtles are found in temperate and subtropical waters and inhabit pelagic waters, continental shelves, bays, estuaries and lagoons. Loggerhead sea turtles are the most abundant species of sea turtle in U.S. waters, commonly occurring throughout the inner continental shelf from Florida through Cape Cod, Massachusetts, and may occur as far north as Nova Scotia when oceanographic and prey conditions are favorable (NEFSC survey data 1999). The loggerhead was listed rangewide as threatened under the ESA on July 28, 1978.

Loggerhead sea turtles are generally grouped by their nesting locations. Nesting is concentrated in the north and south temperate zones and subtropics. Loggerheads generally avoid nesting in tropical areas of Central America, northern South America, and the Old World (National Research Council 1990). The largest known nesting aggregations of loggerhead sea turtles occur

1 Pursuant to NMFS regulations at 50 CFR 223.205, the prohibitions of Section 9 of the Endangered Species Act apply to all green turtles, whether endangered or threatened.

on Masirah and Kuria Muria Islands in Oman (Ross and Barwani 1982). However, the status of the Oman nesting beaches has not been evaluated recently, and their location in a part of the world that is vulnerable to extremely disruptive events (e.g. political upheavals, wars, and catastrophic oil spills) is cause for considerable concern (Meylan et al. 1995).

Pacific Ocean. In the Pacific Ocean, major loggerhead nesting grounds are generally located in temperate and subtropical regions with scattered nesting in the tropics. The abundance of loggerhead turtles on nesting colonies throughout the Pacific basin has declined dramatically over the past 10-20 years. Loggerhead sea turtles in the Pacific are represented by a northwestern Pacific nesting aggregation (located in Japan) and a smaller southwestern nesting aggregation that occurs in Australia (Great Barrier Reef and Queensland), New Caledonia, New Zealand, Indonesia, and Papua New Guinea. Data from 1995 estimated the Japanese nesting aggregation at 1,000 female loggerhead turtles (Bolten *et al.* 1996). More recent estimates are unavailable; however, qualitative reports infer that the Japanese nesting aggregation has declined since 1995 and continues to decline (Tillman 2000). Genetic analyses of female loggerheads nesting in Japan indicate the presence of genetically distinct nesting colonies (Hatase *et al.* 2002). As a result, Hatase *et al.* (2002) suggest that the loss of one of these colonies would decrease the genetic diversity of loggerheads that nest in Japan, and recolonization of the site would not be expected on an ecological time scale. In Australia, long-term census data has been collected at some rookeries since the late 1960's and early 1970's, and nearly all data show marked declines in nesting populations since the mid-1980's (Limpus and Limpus 2003). No recent, quantitative estimates of the size of the nesting aggregation in the southwest Pacific is available, but the nesting aggregation in Queensland, Australia, was as low as 300 females in 1997.

Pacific loggerhead turtles are captured, injured, or killed in numerous Pacific fisheries including Japanese longline fisheries in the western Pacific Ocean and South China Seas; direct harvest and commercial fisheries off Baja California, Mexico, commercial and artisanal swordfish fisheries off Chile, Columbia, Ecuador, and Peru; purse seine fisheries for tuna in the eastern tropical Pacific Ocean, and California/Oregon drift gillnet fisheries. Loggerhead turtle colonies in the western Pacific Ocean have been reduced to a fraction of their former abundance by the combined effects of human activities that have reduced the number of nesting females and reduced the reproductive success of females that manage to nest (e.g., egg poaching).

Indian Ocean. Loggerhead sea turtles are distributed throughout the Indian Ocean, along most mainland coasts and island groups (Baldwin *et al.* 2003). In the southwestern Indian Ocean, loggerhead nesting has shown signs of recovery in South Africa where protection measures have been in place for decades. However, in other southwestern areas (*e.g.*, Madagascar and Mozambique) loggerhead nesting aggregations are still affected by subsistence hunting of adults and eggs (Baldwin *et al.* 2003). The largest known nesting aggregation of loggerheads in the world occurs in Oman in the northern Indian Ocean. An estimated 20,000-40,000 females nest at Masirah, the largest nesting site within Oman, each year (Baldwin *et al.* 2003). All known nesting sites within the eastern Indian Ocean are found in Western Australia (Dodd 1988). As has been found in other areas, nesting numbers are disproportionate within the area with the majority of nesting occurring at a single location. This may, however, be the result of fox predation on eggs at other Western Australia nesting sites (Baldwin *et al.* 2003). Throughout the

Indian Ocean, loggerhead sea turtles face many of the same threats as in other parts of the world including loss of nesting beach habitat, fishery interactions, and turtle meat and/or egg harvesting.

Mediterranean Sea. Nesting in the Mediterranean is confined almost exclusively to the eastern basin (Margaritoulis *et al.* 2003). The greatest number of nests in the Mediterranean are found in Greece with an average of 3,050 nests per year (Margaritoulis *et al.* 2003). There is a long history of exploitation for loggerheads in the Mediterranean (Margaritoulis *et al.* 2003). Although much of this is now prohibited, some directed take still occurs (Margaritoulis *et al.* 2003). Loggerheads in the Mediterranean also face the threat of habitat degradation, incidental fishery interactions, vessel strikes, and marine pollution (Margaritoulis *et al.* 2003).

Atlantic Ocean. In the Atlantic Ocean, loggerheads commonly occur throughout the inner continental shelf from Florida through Cape Cod, Massachusetts although their presence varies with the seasons due to changes in water temperature (Braun and Epperly 1996; Epperly *et al.* 1995a, Epperly *et al.* 1995b; Shoop and Kenney 1992). Aerial surveys of loggerhead turtles north of Cape Hatteras indicate that they are most common in waters from 22 to 49 meters deep although they range from the beach to waters beyond the continental shelf (Shoop and Kenney 1992). The presence of loggerhead turtles in an area is also influenced by water temperature. Loggerheads have been observed in waters with surface temperatures of 7-30°C but water temperatures of at least 11°C are favorable to sea turtles (Epperly *et al.* 1995b; Shoop and Kenney 1992). As coastal water temperatures warm in the spring, loggerheads begin to migrate to North Carolina inshore waters (*e.g.*, Pamlico and Core Sounds) and also move up the coast (Braun-McNeill and Epperly 2004; Epperly *et al.* 1995a; Epperly *et al.* 1995b; Epperly *et al.* 1995c), occurring in Virginia foraging areas as early as April and on the most northern foraging grounds in the Gulf of Maine in June. The trend is reversed in the fall as water temperatures cool. The large majority leaves the Gulf of Maine by mid-September but some may remain in Mid-Atlantic and Northeast areas until late November. By December, loggerheads have migrated from inshore North Carolina waters and more northern coastal waters to waters offshore of North Carolina, particularly off of Cape Hatteras, and waters further south where the influence of the Gulf Stream provides temperatures favorable to sea turtles (Epperly *et al.* 1995b; Shoop and Kenney 1992).

In the western Atlantic, most loggerhead sea turtles nest from North Carolina to Florida and along the Gulf coast of Florida. In 1996, the Turtle Expert Working Group (TEWG) met on several occasions and produced a report assessing the status of the loggerhead sea turtle population in the western North Atlantic. The southeastern U.S. nesting aggregation is the second largest and represents about 35 percent of the nests of this species. From a global perspective, this U.S. nesting aggregations is considered to be critical to the survival of this species.

Based on analysis of mitochondrial DNA (mtDNA), which is maternally inherited, the TEWG theorized that nesting assemblages represent distinct genetic entities, and that there are at least four loggerhead subpopulations in the western North Atlantic separated at the nesting beach (TEWG 1998, 2000). A fifth subpopulation was identified in NMFS SEFSC 2001. As such,

there are at least five western Atlantic subpopulations, divided geographically as follows: (1) a northern nesting subpopulation, occurring from North Carolina to northeast Florida at about 29°N (approximately 7,500 nests in 1998); (2) a south Florida nesting subpopulation, occurring from 29°N on the east coast to Sarasota on the west coast (approximately 83,400 nests in 1998); (3) a Florida Panhandle nesting subpopulation, occurring at Eglin Air Force Base and the beaches near Panama City, Florida (approximately 1,200 nests in 1998); (4) a Yucatán nesting subpopulation, occurring on the eastern Yucatán Peninsula, Mexico (TEWG 2000); and (5) a Dry Tortugas nesting subpopulation, occurring in the islands of the Dry Tortugas, near Key West, Florida (approximately 200 nests per year) (NMFS SEFSC 2001). Genetic analyses conducted at these nesting sites indicate that they are distinct subpopulations (TEWG 2000). Natal homing to the nesting beach is believed to provide the genetic barrier between these nesting aggregations, preventing recolonization from turtles from other nesting beaches. Fine-scale analysis of mtDNA work from Florida rookeries indicate that population separations begin to appear between nesting beaches separated by more than 50-100 km of coastline that does not host nesting (Francisco et al. 1999) and tagging studies are consistent with this result (Richardson 1982, Ehrhart 1979, LeBuff 1990, CMTTP: in NMFS SEFSC 2001). Nest site relocations greater than 100 km occur, but are rare (Ehrhart 1979; LeBuff 1974, 1990; CMTTP; Bjorndal et at. 1983: in NMFS SEFSC 2001). In addition, a recent study by Bowen *et al.* (2004) lends support to the hypothesis that juvenile loggerhead sea turtles exhibit homing behavior with respect to using foraging areas in the vicinity of their nesting beach. Therefore, coastal hazards that affect declining nesting populations may also affect the next generation of turtles when they are feeding in nearby habitats (Bowen *et al.* 2004).

Loggerheads from any of these nesting sites may occur within the action area. However, the majority of the loggerhead turtles in the action area are expected to have come from the northern nesting subpopulation and the south Florida nesting subpopulation with a smaller portion from the Yucatan subpopulation. Rankin-Baransky et. al. examined the genetic composition of loggerheads stranded in the Northeast and determined that 25% were from the northern nesting subpopulation, 59% from the south Florida subpopulation and 16% from the Yucatan subpopulation. Bass et al. (1995) reports that of the sea turtles foraging in Virginia waters, approximately half are from the northern nesting subpopulation and half from the south Florida nesting subpopulation with very few loggerheads from the Mexican subpopulation (less than .07%) occurring in Chesapeake Bay. As the action area for this consultation includes Mid-Atlantic waters, it is likely that loggerheads from these three subpopulations may occur in the action area. Loggerheads from other subpopulations have not been shown to occur in these waters in detectable numbers. As such, in this Opinion NMFS will consider effects of the action on loggerheads from the northern subpopulation, the south Florida subpopulation and the Yucatan subpopulation.

Mating takes place in late March-early June, and eggs are laid throughout the summer, with a mean clutch size of 100-126 eggs in the southeastern U.S. Individual females nest multiple times during a nesting season, with a mean of 4.1 nests per individual (Murphy and Hopkins 1984). Nesting migrations for an individual female loggerhead are usually on an interval of 2-3 years, but can vary from 1-7 years (Dodd 1988). In the western Atlantic, most loggerhead sea turtles nest from North Carolina to Florida and along the gulf coast of Florida.

Like other sea turtles, loggerhead hatchlings enter the pelagic environment upon leaving the nesting beach. Loggerhead sea turtles originating from the western Atlantic nesting aggregations are believed to lead a pelagic existence in the North Atlantic Gyre for as long as 7-12 years before settling into benthic environments where they opportunistically forage on crustaceans and mollusks (Wynne and Schwartz 1999). However, some loggerheads may remain in the pelagic environment for longer periods of time or move back and forth between the pelagic and benthic environment (Witzell 2002). Loggerheads that have entered the benthic environment appear to undertake routine migrations along the coast that appear to be limited by seasonal water temperatures. Aerial surveys suggest that loggerheads (benthic immatures and adults) in U.S. waters are distributed in the following proportions: 54% in the southeast U.S. Atlantic, 29% in the northeast U.S. Atlantic, 12% in the eastern Gulf of Mexico, and 5% in the western Gulf of Mexico (TEWG 1998).

Loggerheads appear to concentrate in nearshore and southerly areas influenced by warmer Gulf Stream waters off North Carolina during November and December (Epperly et al. 1995a). Support for these loggerhead movements are provided by the collected work of Morreale and Standora (1998) who showed through satellite tracking that 12 loggerheads traveled along similar spatial and temporal corridors from Long Island Sound, New York, in a time period of October through December, within a narrow band along the continental shelf before taking up residence for one or two months south of Cape Hatteras.

A number of stock assessments (TEWG 1998; 2000; NMFS SEFSC 2001; Heppell *et al.* 2003) have examined the stock status of loggerheads in the waters of the U.S., but have been unable to develop any reliable estimates of absolute population size. Due to the difficulty of conducting comprehensive population surveys away from nesting beaches, nesting beach survey data are used to index the status and trends of loggerheads (USFWS and NMFS 2003).

Nesting beach surveys count the number of nests. As alluded to above, the number of nests laid are a function of the number of reproductively mature females in the population and the number of times that they nest per season. Between 1989 and 1998, the total number of nests laid along the U.S. Atlantic and Gulf coasts ranged from 53,014 to 92,182, annually with a mean of 73,751 (TEWG 2000). The south Florida nesting group is the largest known loggerhead nesting assemblage in the Atlantic and one of only two loggerhead nesting assemblages worldwide that has greater than 10,000 females nesting per year (USFWS and NMFS 2003; USFWS Fact Sheet). Annual nesting totals have ranged from 48,531 - 83,442 annually over the past decade (USFWS and NMFS 2003). South Florida nests make up the majority (90.7%) of all loggerhead nests counted along the U.S. Atlantic and Gulf coasts during the period 1989-1998. The northern subpopulation is the second largest loggerhead nesting assemblage within the U.S. but much smaller than the south Florida nesting group. Of the total number of nests counted along the U.S. Atlantic and Gulf coasts during the period 1989-1998, 8.5% were attributed to the northern subpopulation. The number of nests for this subpopulation has ranged from 4,370 - 7,887 for the period 1989-1998, for an average of approximately 1,524 nesting females per year (USFWS and NMFS 2003). The remaining three subpopulations (the Dry Tortugas, Florida Panhandle, and Yucatán) are much smaller subpopulations. Annual nesting totals for the Florida Panhandle

subpopulation ranged from 113-1,285 nests for the period 1989-2002 (USFWS and NMFS 2003). The Yucatán nesting group was reported to have had 1,052 nests in 1998 (TEWG 2000). Nest counts for the Dry Tortugas subpopulation ranged from 168 to 270 during the 9-year period from 1995-2003.

While nesting beach data is a useful tool for assessing sea turtle populations, the detection of nesting trends requires consistent data collection methods over long periods of time (USFWS and NMFS 2003). In 1989, a statewide sea turtle Index Nesting Beach Survey (INBS) program was developed and implemented in Florida, and similar standardized daily survey programs have been implemented in Georgia, South Carolina, and North Carolina (USFWS and NMFS 2003). Currently available nesting trend data for these subpopulations from the INBS program is still too limited to indicate statistically reliable trends (Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute, Statewide and Index Nesting Beach Survey Programs; USFWS and NMFS 2003). Although not part of the INBS program, nesting survey data are also available for the Yucatán Peninsula, Mexico (USFWS and NMFS 2003). Similarly, nesting surveys for the Dry Tortugas subpopulation have been conducted as part of Florida's statewide survey program since 1995 (although the 2002 year was missed), but no conclusion on the nesting trend for the subpopulation can be made at this time given the relatively short period of survey effort (Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute, Statewide Nesting Beach Survey Data). Similarly, although Zurita *et al.* (2003) did find significant increases in loggerhead nesting on seven beaches at Quintana Roo, Mexico, nesting survey effort overall has been inconsistent among the Yucatán nesting beaches and no trend can be determined for this subpopulation given the currently available data.

More reliable nesting trend information is available from some south Florida and northern subpopulation nesting beaches that have been surveyed for longer periods of time. Using the information gathered from these select south Florida and northern subpopulation nesting beaches, the Turtle Expert Working Group (TEWG) concluded that the south Florida subpopulation was increasing based on nesting data over the last couple of decades, and that the northern subpopulation was stable or declining (TEWG 2000). Trend data for these nesting beaches are expected to be reviewed and the information provided in a revised Loggerhead Sea Turtle Recovery Plan. However, preliminary review of nesting trend data from several sources for the northern and south Florida nesting beaches now suggest: (1) a declining trend in nesting for 11 beaches in North Carolina, South Carolina and Georgia of 2% annually over a 23 year period (1982-2005) (Barbara Schroeder, NMFS, pers. comm.), (2) a declining trend of 3.3% annually for South Carolina beaches since 1980 (Barbara Schroeder, NMFS, pers. comm.), and (3) an overall decline in nesting of 29% for the south Florida subpopulation during the period 1989-2005 (A. Meylan, presentation at the 26th Annual Symposium on Sea Turtle Biology and Conservation, April 2006).

Nesting trend data must be interpreted cautiously when using it to assess population trends for sea turtles. In general, census of nesting females only reflects the number of reproductively active females (Zurita *et al.* 2003). Females and males that are not reproductively active may not reflect the same tendencies (Ross 1996). Without knowing the proportion of males to females and the age structure of the population, it is impossible to extrapolate the data from nesting

beaches to the entire population (Zurita *et al.* 2003; Meylan 1982). In the case of loggerheads, there is currently insufficient information to determine whether the current impacts to mature females are experienced to the same degree amongst all age classes regardless of sex, and/or that the impacts that led to the current abundance of nesting females are affecting the current immature females to the same extent. Adding to the difficulties associated with using loggerhead nesting trend data as an indicator of subpopulation status is the late age to maturity for loggerhead sea turtles. Past literature gave an estimated age at maturity for loggerhead sea turtles of 21-35 years (Frazer and Ehrhart 1985; Frazer *et al.* 1994) with the benthic immature stage lasting at least 10-25 years. New data from tag returns, strandings, and nesting surveys suggested estimated ages of maturity ranging from 20-38 years and the benthic immature stage lasting from 14-32 years (NMFS SEFSC 2001). Given the late age to maturity, there is a greater risk that the factors affecting the number of currently nesting females are not the same as the factors affecting the number of loggerhead sea turtles in the other age classes. Multiple management actions have been implemented in the United States over the last 20 years or less that either directly or indirectly address the known sources of mortality for loggerhead sea turtles (*e.g.*, fishery interactions, power plant entrainment, destruction of nesting beaches, etc.).

In 2001, NMFS (SEFSC) reviewed and updated the stock assessment for loggerhead sea turtles of the western Atlantic (NMFS SEFSC 2001). The assessment reviewed and updated information on nesting abundance and trends, estimation of vital rates (including age to maturity), evaluation of genetic relationships between populations, and evaluation of available data on other anthropogenic effects on these populations since the TEWG reports (1998; 2000). In addition, the assessment also looked at the impact of the U.S. pelagic longline fishery on loggerheads with and without the proposed changes in the Turtle Excluder Device (TED) regulations for the shrimp fishery using a modified population model from Heppell *et al.* (2003)[2]. NMFS SEFSC (2001) modified the model developed by Heppell *et al.* (2003) to include updated vital rate information (*e.g.*, new estimates of the duration of life stages and time to maturity) and, unlike Heppell *et al.* (2003), also considered sex ratios other than 1:1 (NMFS SEFSC 2001). The latter is an important point since studies have suggested that the proportion of females produced by the northern subpopulation is only 35% while the proportion of females produced by the south Florida subpopulation is 80% (NMFS SEFSC 2001).

The assessment looked at the impact of the proposed changes in the Turtle Excluder Device (TED) regulations for the shrimp fishery, as well as the U.S. pelagic longline fishery on loggerheads. NMFS SEFSC (2001) constructed models based on a 30% decrease in small benthic juvenile mortality based on research findings of (existing) TED effectiveness (Crowder *et al.* 1995; NMFS SEFSC 2001; Heppell *et al.* 2003). Model runs were then compared with respect to the change in population status as a result of implementing the requirement for larger TEDs (Epperly *et al.* 2002) alone and also when combined with other changes in survival rate from the pelagic long line fishery. The results of the modeling indicated that the proposed

2 Although Heppell *et al.* is a later publication, NMFS SEFSC 2001 is actually a more up-to-date version of the modeling approach. Due to differences in publication times, Heppell *et al.* (2003) was published after NMFS SEFSC 2001.

change in the TED regulations which would allow larger benthic immature loggerheads and sexually mature loggerheads to escape from shrimp trawl gear would have a positive or at least stabilizing influence on the subpopulation in nearly all scenarios. Coupling the anticipated effect of the proposed TED changes with changes in the survival rate of pelagic immature loggerheads revealed that subpopulation status would be positive or at least stable. Coupling the anticipated effect of the proposed TED changes with changes in the survival rate of pelagic immature loggerheads revealed that subpopulation status would be positive or at least stable when pelagic immature survival was changed by 0 to +10% in all but the most conservative model scenarios.

Given the late age at maturity for loggerhead sea turtles and the normal fluctuations in nesting, changes in population size as a result of the larger TED requirements and measures to address pelagic immature survival in the U.S. Atlantic longline fishery for swordfish are unlikely to be evident in nesting beach censuses for many years to come. NMFS' SEFSC (2001) assessment was reviewed by three independent experts from the Center for Independent Experts, in 2001. As a result, NMFS SEFSC's stock assessment report, the reviews of it, and the body of scientific literature upon which these documents were derived represent the best available scientific and commercial information for Atlantic loggerheads.

Threats to loggerhead sea turtle recovery

The diversity of a sea turtle's life history leaves them susceptible to many natural and human impacts, including impacts while they are on land, in the benthic environment, and in the pelagic environment. Hurricanes are particularly destructive to sea turtle nests. Sand accretion and rainfall that result from these storms as well as wave action can appreciably reduce hatchling success. For example, in 1992, all of the eggs over a 90-mile length of coastal Florida were destroyed by storm surges on beaches that were closest to the eye of Hurricane Andrew (Milton *et al.* 1994). Reports suggest that extensive loggerhead nest destruction occurred in Florida and other southern states in 2004 due to damage from multiple hurricanes and storm events. Other sources of natural mortality include cold stunning and biotoxin exposure. For example, in the winter of 2004/2005, 2 loggerheads died due to cold stunning on Cape Cod beaches and in the winter of 2005/2006, six loggerheads were cold stunned, with 2 deaths (S. McNulty, NMFS, pers. comm.).

Anthropogenic factors that impact hatchlings and adult female turtles on land, or the success of nesting and hatching include: beach erosion, beach armoring and nourishment; artificial lighting; beach cleaning; increased human presence; recreational beach equipment; beach driving; coastal construction and fishing piers; exotic dune and beach vegetation; and poaching. An increased human presence at some nesting beaches or close to nesting beaches has led to secondary threats such as the introduction of exotic fire ants, feral hogs, dogs and an increased presence of native species (*e.g.*, raccoons, armadillos, and opossums) which raid and feed on turtle eggs. Although sea turtle nesting beaches are protected along large expanses of the northwest Atlantic coast (in areas like Merritt Island, Archie Carr, and Hobe Sound National Wildlife Refuges), other areas along these coasts have limited or no protection. Sea turtle nesting and hatching success on unprotected high density east Florida nesting beaches from Indian River to Broward County are affected by all of the above threats.

Sea turtles, including loggerhead sea turtles, are affected by a different set of anthropogenic threats in the marine environment. These include oil and gas exploration, coastal development, and transportation, marine pollution, underwater explosions, hopper dredging, offshore artificial lighting, power plant entrainment and/or impingement, entanglement in debris, ingestion of marine debris, marina and dock construction and operation, boat collisions, poaching, and fishery interactions. In the pelagic environment loggerheads are exposed to a series of long-line fisheries that include the U.S. Atlantic tuna and swordfish longline fisheries, an Azorean long-line fleet, a Spanish long-line fleet, and various fleets in the Mediterranean Sea (Aguilar *et al.* 1995; Bolten *et al.* 1994; Crouse 1999). In the waters off the coastal U.S., loggerheads are exposed to a suite of fisheries in Federal and State waters including trawl, purse seine, hook and line, gillnet, pound net, longline, dredge, and trap fisheries.

Power plants can also pose a danger of injury and mortality for loggerheads. In Florida, thousands of sea turtles have been entrained in the St. Lucie Nuclear Power Plant's intake canal over the past several decades (Bresette *et al.* 2003). From May 1976 - November 2001, 7,795 sea turtles were captured in the intake canal (Bresette *et al.* 2003). Approximately 57% of these were loggerheads (Bresette *et al.* 2003). Procedures are in place to capture the entrained turtles and release them. This has helped to keep mortality below 1% since 1990 (Bresette *et al.* 2003). The Salem Nuclear Generating Station in New Jersey is also known to capture sea turtles although the numbers are far less than those observed at St. Lucie, FL. As is the case at St. Lucie, procedures are in place for checking for the presence of sea turtles and rescuing sea turtles that are found within the intake canals. Three loggerheads have been recovered from the Salem intakes since 2000, with one turtle released alive. Dredging activities also pose a danger of injury and mortality for loggerheads. Sea turtle deaths in dredging operations have been documented throughout the eastern U.S. At least 50 loggerheads have been documented to have been killed in northeast dredging projects since 1994, including 4 loggerheads killed during dredging operations in the ACOE Philadelphia District.

Summary of Status for Loggerhead Sea Turtles

The loggerhead sea turtle is listed throughout its range as threatened under the ESA. In the Pacific Ocean, loggerhead turtles are represented by a northwestern Pacific nesting aggregation (located in Japan) and a smaller southwestern nesting aggregation that occurs in Australia (Great Barrier Reef and Queensland), New Caledonia, New Zealand, Indonesia, and Papua New Guinea. The abundance of loggerhead turtles on nesting colonies throughout the Pacific basin have declined dramatically over the past 10 to 20 years by the combined effects of human activities that have reduced the number of nesting females and reduced the reproductive success of females that manage to nest (*e.g.*, due to egg poaching).

Loggerhead sea turtles also occur in the Indian Ocean and Mediterranean Sea. Nesting beaches in the southwestern Indian Ocean at Tongaland, South Africa have been protected for decades and sea turtle nesting shows signs of increasing (Baldwin *et al.* 2003). However, other southwestern Indian Ocean beaches are unprotected and both poaching of eggs and adults continues in some areas. The largest nesting aggregation of loggerhead sea turtles in the world occurs in Oman, principally on the island of Masirah. Oman does not have beach protection measures for loggerheads (Baldwin *et al.* 2003). Sea turtles in the area are affected by fishery

interactions, development of coastal areas, and egg harvesting. In the eastern Indian Ocean, nesting is known to occur in western Australia. All known nesting sites within the eastern Indian Ocean are found in Western Australia (Dodd 1988). As has been found in other areas, nesting numbers are disproportionate within the area with the majority of nesting occurring at a single location. This may, however, be the result of fox predation on eggs at other Western Australia nesting sites (Baldwin *et al.* 2003).

There are at least five western Atlantic loggerhead subpopulations (NMFS SEFSC 2001; TEWG 2000; Márquez 1990). As noted above, cohorts from three of these populations, the south Florida, Yucatán, and northern subpopulations, are likely to occur in the action area for this consultation. The south Florida nesting group is the largest known loggerhead nesting assemblage in the Atlantic and one of only two loggerhead nesting assemblages worldwide that have greater than 10,000 females nesting per year (USFWS and NMFS 2003; USFWS Fact Sheet). The northern subpopulation is the second largest loggerhead nesting assemblage within the United States. The remaining three subpopulations (the Dry Tortugas, Florida Panhandle, and Yucatán) are much smaller subpopulations with nest counts ranging from roughly 100 - 1,000 nests per year.

Loggerheads are a long-lived species and reach sexual maturity relatively late; 20-38 years (NMFS SEFSC 2001). The INBS program helps to track loggerhead status through nesting beach surveys. However, given the cyclical nature of loggerhead nesting, and natural events that sometimes cause destruction of many nests in a nesting season, multiple years of nesting data are needed to detect relevant nesting trends in the population. The INBS program has not been in place long enough to provide statistically reliable information on the subpopulation trends for western Atlantic loggerheads. In addition, given the late age to maturity for loggerhead sea turtles, nesting data represents effects to female loggerheads that have occurred through the various life stages over the past couple of decades. Therefore, caution must be used when interpreting nesting trend data since they may not be reflective of the current subpopulation trend if effects to the various life stages have changed.

All loggerhead subpopulations are faced with a multitude of natural and anthropogenic effects. Many anthropogenic effects occur as a result of activities outside of U.S. jurisdiction (*i.e.*, fisheries in international waters). For the purposes of this consultation, NMFS will assume that the southern Florida and northern subpopulations of loggerhead sea turtles are declining (the conservative estimate) or stable (the optimistic estimate), and the Yucatan subpopulation of loggerhead sea turtles is increasing (the optimistic estimate) or stable (the conservative estimate).

Green Sea Turtle

Green turtles are the largest chelonid (hard-shelled) sea turtle, with an average adult carapace of 91 cm SCL and weight of 150 kg. Based on growth rate studies of wild green turtles, greens have been found to grow slowly with an estimated age of sexual maturity ranging from 18 to 40 years (Balazs 1982; Frazer and Ehrhart 1985; B. Schroeder pers. comm.). Green turtles are distributed circumglobally, and can be found in the Pacific and Atlantic Oceans. In 1978, the Atlantic population of the green sea turtle was listed as threatened under the ESA, except for the breeding populations in Florida and on the Pacific coast of Mexico, which were listed as

endangered. As it is difficult to differentiate between breeding populations away from the nesting beaches, all green sea turtles, in water, are considered endangered.

Pacific Ocean. In the Pacific Ocean, green sea turtles can be found along the west coast of the U.S., the Hawaiian Islands, Oceania, Guam, the Northern Mariana Islands, and American Samoa. Along the Pacific coast, green turtles have been reported as far north as British Columbia, but a large number of the Pacific coast sightings occur in northern Baja California and southern California (NMFS and USFWS 1996). The main nesting sites for the East Pacific green turtle are located in Michoacan, Mexico, and in the Galapagos Islands, Ecuador, with no known nesting of East Pacific green turtles occurring in the U.S. Between 1982 and 1989, the estimated nesting population in Michoacan ranged from a high of 5,585 females in 1982 to a low of 940 in 1984 (NMFS and USFWS 1996). Current population estimates are unavailable.

Atlantic Ocean. In the western Atlantic, green sea turtles range from Massachusetts to Argentina, including the Gulf of Mexico and Caribbean (Wynne and Schwartz 1999). Green turtle occurrences are infrequent north of Cape Hatteras, but they do occur in mid-Atlantic and northeast waters (e.g., documented in Long Island Sound (Morreale 2003) and cold stunned in Cape Cod Bay, Massachusetts (NMFS unpub. data)). For example, in the winters of 2004/2005 and 2005/2006, a total of three green sea turtles were found coldstunned on Cape Cod beaches.

In the continental U.S., green turtle nesting occurs on the Atlantic coast of Florida (Ehrhart 1979). Occasional nesting has been documented along the Gulf coast of Florida, at southwest Florida beaches, as well as the beaches on the Florida Panhandle (Meylan *et al.* 1995). More recently, green turtle nesting occurred on Bald Head Island, North Carolina just east of the mouth of the Cape Fear River, on Onslow Island, and on Cape Hatteras National Seashore. Increased nesting has also been observed along the Atlantic Coast of Florida, on beaches where only loggerhead nesting was observed in the past (Pritchard 1997). Certain Florida nesting beaches have been designated index beaches. Index beaches were established to standardize data collection methods and effort on key nesting beaches. The pattern of green turtle nesting shows biennial peaks in abundance, with a generally positive trend during the ten years of regular monitoring since establishment of the index beaches in 1989, perhaps due to increased protective legislation throughout the Caribbean (Meylan et al. 1995). Recent population estimates for the western Atlantic area are not available.

While nesting activity is important in determining population distributions, the remaining portion of the green turtles life is spent on the foraging and breeding grounds. Juvenile green sea turtles occupy pelagic habitats after leaving the nesting beach. Pelagic juveniles are assumed to be omnivorous, but with a strong tendency toward carnivory during early life stages (Bjorndal 1985). At approximately 20 to 25 cm carapace length, juveniles leave pelagic habitats and enter benthic foraging areas, shifting to a chiefly herbivorous diet but may also consume jellyfish, salps, and sponges (Bjorndal 1997). Some of the principal feeding pastures in the western Atlantic Ocean include the upper west coast of Florida and the northwestern coast of the Yucatan Peninsula. Additional important foraging areas in the western Atlantic include the Mosquito and Indian River Lagoon systems and nearshore wormrock reefs between Sebastian and Ft. Pierce Inlets in Florida, Florida Bay, the Culebra archipelago and other Puerto Rico coastal waters, the

south coast of Cuba, the Mosquito Coast of Nicaragua, the Caribbean Coast of Panama, and scattered areas along Colombia and Brazil (Hirth 1971). In North Carolina, green turtles are known to occur in estuarine and oceanic waters and to nest in low numbers along the entire coast. The summer developmental habitat for green turtles also encompasses estuarine and coastal waters of Chesapeake Bay and as far north as Long Island Sound (Musick and Limpus 1997).

Green turtles face many of the same natural threats as loggerhead and Kemp's ridley sea turtles. In addition, green turtles appear to be susceptible to fibropapillomatosis, an epizootic disease producing lobe-shaped tumors on the soft portion of a turtle's body. Juveniles are most commonly affected. The occurrence of fibropapilloma tumors may result in impaired foraging, breathing, or swimming ability, leading potentially to death.

Threats to sea turtle recovery

Green turtles were traditionally highly prized for their flesh, fat, eggs, and shell, and directed fisheries in the United States and throughout the Caribbean are largely to blame for the decline of the species. In the Gulf of Mexico, green turtles were once abundant enough in the shallow bays and lagoons to support a commercial fishery. In 1890, over one million pounds of green turtles were taken in the Gulf of Mexico green sea turtle fishery (Doughty 1984). However, declines in the turtle fishery throughout the Gulf of Mexico were evident by 1902 (Doughty 1984).

As with the other sea turtle species, fishery mortality accounts for a large proportion of annual human-caused mortality outside the nesting beaches, while other activities like dredging, pollution, and habitat destruction account for an unknown level of other mortality. Stranding reports indicate that between 200-400 green turtles strand annually along the Eastern U.S. coast from a variety of causes most of which are unknown (STSSN database). Sea sampling coverage in the pelagic driftnet, pelagic longline, southeast shrimp trawl, and summer flounder bottom trawl fisheries has recorded takes of green turtles.

Summary of Status of Green Sea Turtles

The global status and trend of green sea turtles is difficult to summarize. In the Pacific Ocean, green turtles are frequent along a north-south band from 15°N to 5°S along 90°W, and between the Galapagos Islands and Central American coast (NMFS and USFWS 1996), but current population estimates are unavailable. Green turtles range in the western Atlantic from Massachusetts to Argentina, including the Gulf of Mexico and Caribbean. Green turtles face many of the same natural and anthropogenic threats as loggerhead and Kemp's ridley sea turtles. In addition, green turtles are also susceptible to fibropapillomatosis which can result in death. In the continental U.S., green turtle nesting occurs on the Atlantic coast of Florida (Ehrhart 1979). Recent population estimates for the western Atlantic area are not available. However, the pattern of green turtle nesting shows biennial peaks in abundance, with a generally positive trend during the ten years of regular monitoring since establishment of index beaches in 1989. There is cautious optimism that the green sea turtle population is increasing in the Atlantic. For purposes of this consultation, NMFS will assume that the green sea turtle population is increasing (best case) or at worst is stable.

Kemp's Ridley Sea Turtles

The Kemp's ridley is considered the most endangered sea turtle species. Of the world's seven extant species of sea turtles, the Kemp's ridley has declined to the lowest population level. The Kemp's ridley sea turtle was listed as endangered throughout its range on December 2, 1970 under United States law. The Kemp's ridley is now protected under the ESA.

The only major nesting site for Kemp's ridleys is a single stretch of beach near Rancho Nuevo, Tamaulipas, Mexico (Carr 1963). When nesting aggregations at Rancho Nuevo were discovered in 1947, adult female populations were estimated to be in excess of 40,000 individuals (Hildebrand 1963), but the population has been drastically reduced from these historical numbers. However, the TEWG (1998, 2000) indicated that the Kemp's ridley population appears to be in the early stage of a recovery trajectory. Conservation efforts by Mexican and U.S. agencies have aided this species by eliminating egg harvest, protecting eggs and hatchlings, and reducing at-sea mortality through fishing regulations. Nesting data, estimated number of adults, and percentage of first time nesters have all increased from lows experienced in the 1970s and 1980s. From 1985 to 1999, the number of nests observed at Rancho Nuevo and nearby beaches has increased at a mean rate of 11.3% per year, allowing cautious optimism that the population is on its way to recovery. For example, data from nests at Rancho Nuevo, North Camp and South Camp, Mexico, have indicated that the number of adults declined from a population that produced 6,000 nests in 1966 to a population that produced 924 nests in 1978 and 702 nests in 1985, then increased to produce 1,940 nests in 1995 and about 3,400 nests in 1999. Total nests for the state of Tamaulipas and Veracruz in 2003 was 8,323 (E. Possardt, USFWS, pers. comm.); Rancho Nuevo alone documented 4,457 nests. Estimates of adult abundance followed a similar trend from an estimate of 9,600 in 1966 to 1,050 in 1985 and 3,000 in 1995. The increased recruitment of new adults is illustrated in the proportion of neophyte, or first time nesters, which has increased from 6 to 28 percent from 1981 to 1989 and from 23 to 41 percent from 1990 to 1994. The population model in the TEWG report projected that Kemp's ridleys could reach the intermediate recovery goal identified in the Recovery Plan, of 10,000 nesters by the year 2020, if the assumptions of age to sexual maturity and age specific survivorship rates plugged into their model are correct. The population growth rate does not appear as steady as originally forecasted by the TEWG, but annual fluctuations, due in part to irregular internesting periods, are normal for other sea turtle populations. Also, as populations increase and expand, nesting activity would be expected to be more variable.

Kemp's ridley nesting occurs from April through July each year. Little is known about mating but it is believed to occur at or before the nesting season in the vicinity of the nesting beach. Hatchlings emerge after 45-58 days. Once they leave the beach, neonates presumably enter the Gulf of Mexico where they feed on available sargassum and associated infauna or other epipelagic species (USFWS and NMFS 1992). The presence of juvenile turtles along both the Atlantic and Gulf of Mexico coasts of the U.S., where they are recruited to the coastal benthic environment, indicates that post-hatchlings are distributed in both the Gulf of Mexico and Atlantic Ocean (TEWG 2000). The location and size classes of dead turtles recovered by the Sea Turtle Stranding and Salvage Network (STSSN) suggests that benthic immature developmental areas occur in many areas along the U.S. coast and that these areas may change given resource quality and quantity (TEWG 2000).

Juvenile Kemp's ridleys use northeastern and mid-Atlantic coastal waters of the U.S. Atlantic coastline as primary developmental habitat during summer months, with shallow coastal embayments serving as important foraging grounds. Ridleys found in mid-Atlantic waters are primarily post-pelagic juveniles averaging 16 inches in carapace length, and weighing less than 44 pounds (Terwilliger and Musick 1995). Next to loggerheads, Kemp's ridleys are the second most abundant sea turtle in Virginia and Maryland waters, arriving in these areas during May and June (Keinath *et al.* 1987; Musick and Limpus 1997) and on northern foraging grounds in late June. In the Chesapeake Bay, where the juvenile population of Kemp's ridley sea turtles is estimated to be 211 to 1,083 turtles (Musick and Limpus 1997), ridleys frequently forage in submerged aquatic grass beds for crabs (Musick and Limpus 1997). Blue crabs and spider crabs are key components of the Kemp's ridley diet, as noted during examination of stranded sea turtle stomach contents (Seney 2003). Upon leaving the northern foraging grounds, including the Chesapeake Bay in autumn, juvenile ridleys migrate down the coast, passing Cape Hatteras in December and January (Musick and Limpus 1997). Larger juveniles from the Chesapeake Bay are joined there by juveniles of the same size from North Carolina sounds and smaller juveniles from New York and New England to form one of the densest concentrations of Kemp's ridleys outside of the Gulf of Mexico (Musick and Limpus 1997; Epperly *et al.* 1995a; Epperly *et al.* 1995b).

From telemetry studies, Morreale and Standora (1994) determined that Kemp's ridleys are sub-surface animals that frequently swim to the bottom while diving. The generalized dive profile showed that the turtles spend 56% of their time in the upper third of the water column, 12% in mid-water, and 32% on the bottom. In water shallower than 15 m (50 ft), the turtles dive to depth, but spend a considerable portion of their time in the upper portion of the water column. In contrast, turtles in deeper water dive to depth, spending as much as 50% of the dive on the bottom.

Threats to Kemp's ridley recovery

Kemp's ridleys face many of the same natural threats as other sea turtle species, including destruction of nesting habitat from storm events, natural predators at sea, and oceanic events such as cold-stunning. Although cold-stunning can occur throughout the range of the species, it may be a greater risk for sea turtles that utilize the more northern habitats of Cape Cod Bay and Long Island Sound. For example, in the winter of 1999/2000, there was a major cold-stunning event where 218 Kemp's ridleys, 54 loggerheads, and 5 green turtles were found on Cape Cod beaches (R. Prescott, pers. comm.). In the winter of 2003/2004, 79 Kemp's ridleys were found cold stunned on Cape Cod beaches. In the winter of 2004/2005, 32 Kemp's ridleys were found, with 19 deaths. Numbers from the 2005/2006 season are still preliminary but indicate that 29 Kemp's ridleys were coldstunned, with 15 animals dying (S. McNulty, NMFS, pers. comm.). Annual cold stun events do not always occur at this magnitude; the extent of episodic major cold stun events may be associated with numbers of turtles utilizing Northeast waters in a given year, oceanographic conditions and the occurrence of storm events in the late fall. Although many cold-stun turtles can survive if found early enough and transferred to a rehabilitation facility, cold-stunning events can represent a significant cause of natural mortality.

Like other turtle species, the severe decline in the Kemp's ridley population appears to have been heavily influenced by a combination of exploitation of eggs and impacts from fishery interactions. From the 1940s through the early 1960s, nests from Ranch Nuevo were heavily exploited (USFWS and NMFS 1992), but beach protection in 1966 helped to curtail this activity (USFWS and NMFS 1992). Following World War II, there was a substantial increase in the number of trawl vessels, particularly shrimp trawlers, in the Gulf of Mexico where adult Kemp's ridley turtles occur. Information from fishers helped to demonstrate the high number of turtles taken in these shrimp trawls (USFWS and NMFS 1992). Subsequently, NMFS has worked with the industry to reduce turtle takes in shrimp trawls and other trawl fisheries, including the development and use of TEDs. Sea sampling coverage in the Northeast otter trawl fishery, and southeast shrimp and summer flounder bottom trawl fisheries have recorded takes of Kemp's ridley turtles. Although changes in the use of shrimp trawls and other trawl gear have helped to reduce mortality of Kemp's ridleys, this species is also affected by other sources of anthropogenic impacts similar to those discussed above. For example, in the spring of 2000, a total of five Kemp's ridley carcasses were recovered from the same North Carolina beaches where 275 loggerhead carcasses were found. Cause of death for most of the turtles recovered was unknown, but the mass mortality event was suspected to have been from a large-mesh gillnet fishery operating offshore in the preceding weeks. The five ridley carcasses that were found are likely to have been only a minimum count of the number of Kemp's ridleys that were killed or seriously injured as a result of the fishery interaction since it is unlikely that all of the carcasses washed ashore. Four Kemp's ridleys have been documented as killed during dredging operations in the Northeast US since 1994.

Summary of Status of Kemp's Ridley Sea Turtles
The only major nesting site for ridleys is a single stretch of beach near Rancho Nuevo, Tamaulipas, Mexico (Carr 1963). From 1985 to 1999, the number of nests observed at Rancho Nuevo and nearby beaches increased at a mean rate of 11.3% per year. Current totals exceed 3000 nests per year (TEWG 2000). Kemp's ridleys mature at an earlier age (7 - 15 years) than other chelonids, thus 'lag effects' as a result of unknown impacts to the non breeding life stages would likely have been seen in the increasing nest trend beginning in 1985 (USFWS and NMFS 1992).

The TEWG (1998) developed a population model to evaluate trends in the Kemp's ridley population through the application of empirical data and life history parameter estimates chosen by the TEWG. Model results identified three trends in benthic immature Kemp's ridleys. Benthic immatures are those turtles that are not yet reproductively mature but have recruited to feed in the nearshore benthic environment where they are available to nearshore mortality sources that often result in strandings. Benthic immature ridleys are estimated to be 2-9 years of age and 20-60 cm in length. Increased production of hatchlings from the nesting beach beginning in 1966 resulted in an increase in benthic ridleys that leveled off in the late 1970s. A second period of increase followed by leveling occurred between 1978 and 1989 as hatchling production was further enhanced by the cooperative program between the USFWS and Mexico's Instituto Nacional de Pesca to increase the nest protection and relocation program in 1978. A third period of steady increase, which has not leveled off to date, has occurred since 1990 and

appears to be due to the greatly increased hatchling production and an apparent increase in survival rates of immature turtles beginning in 1990 due, in part, to the introduction of TEDs.

The population model in the TEWG report projected that Kemp's ridleys could reach the intermediate recovery goal identified in the Recovery Plan of 10,000 nesters by the year 2020 if the assumptions of age to sexual maturity and age specific survivorship rates plugged into their model are correct. The TEWG (1998) identified an average Kemp's ridley population growth rate of 13% per year between 1991 and 1995. Total nest numbers have continued to increase. However, the 1996 and 1997 nest numbers reflected a slower rate of growth, while the increase in the 1998 nesting level has been much higher and decreased in 1999. The population growth rate does not appear as steady as originally forecasted by the TEWG, but annual fluctuations, due in part to irregular inter-nesting periods, are normal for other sea turtle populations. Also, as populations increase and expand, nesting activity would be expected to be more variable.

One area for caution in the TEWG findings is that the area surveyed for ridley nests in Mexico was expanded in 1990 due to destruction of the primary nesting beach by Hurricane Gilbert. Because systematic surveys of the adjacent beaches were not conducted prior to 1990, there is no way to determine what proportion of the nesting increase documented since that time is due to the increased survey effort rather than an expanding ridley nesting range. The TEWG (1998) assumed that the observed increase in nesting, particularly since 1990, was a true increase rather than the result of expanded beach coverage. As noted by TEWG, trends in Kemp's ridley nesting even on the Rancho Nuevo beaches alone suggest that recovery of this population has begun but continued caution is necessary to ensure recovery.

ENVIRONMENTAL BASELINE

Environmental baselines for biological opinions include the past and present impacts of all state, federal or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early Section 7 consultation, and the impact of state or private actions that are contemporaneous with the consultation in process (50 CFR 402.02). The environmental baseline for this Opinion includes the effects of several activities that may affect the survival and recovery of the listed species in the action area. The activities that shape the environmental baseline in the action area of this consultation generally include: dredging operations, water quality, scientific research, shipping and other vessel traffic and fisheries, and recovery activities associated with reducing those impacts.

Federal Actions that have Undergone Formal or Early Section 7 Consultation

The only project within the action area that has been subject to formal section 7 consultation has been the operation of the OCNGS. Details of these previous consultations were noted in the Background section (see page 1). The impact of the historical operation of the OCNGS on listed sea turtles is detailed below.

Impacts of the Historical Operation of the OCNGS

As noted above, the OCGNS was constructed in the 1960s and began generating power in 1969. No sea turtles were observed at the facility until 1992. However, between 1969 and 1992 there

was no directed attempt to document sea turtles at the facility and the frequency and efficiency of monitoring the intakes prior to 1992 has not been determined. Since 1992 there have been a total of 41 recorded takes at the OCNGS (see Figures 1 and 2 above and Appendix 1 for details).

Between June 1992 and July 1994, 9 sea turtle impingements occurred at the OCNGS intake trash bars, including 5 loggerheads (1 recapture) and 4 Kemp's ridleys. Three of the loggerheads and 1 of the Kemp's ridleys were recovered alive. The remaining turtles were recovered dead from the intake trash bars. Of the 5 dead sea turtles, 3 were necropsied. Necropsy results for 2 of the 3 sea turtles indicated that they had died prior to becoming impinged at the intakes (1 loggerhead, 1 Kemp's ridley), while the remaining turtle, a Kemp's ridley, likely drowned at the intakes. Of the 2 sea turtles that were not necropsied, 1 of them displayed signs of injury or decomposition that indicated it may have died prior to becoming impinged on the intakes.

There were no sea turtle takes observed in 1995 or 1996. One Kemp's ridley turtle was lethally taken in 1997. No necropsy was completed for this turtle; however, the lack of significant injuries or signs of decomposition indicate it likely died at the intakes. In 1998, one loggerhead was recovered alive.

Between 1999 and 2006 at total of 30 sea turtle impingements have been documented at the OCNGS intake structures. Of these 30 turtles, (22 Kemp's ridley, 4 loggerheads, and 4 green), 21 of the turtles were recovered alive. Of the 9 dead sea turtles (8 Kemp's, 1 green), necropsy results are available for 3 Kemp's ridleys. Necropsy results indicate that 1 of the turtles likely died from drowning at the intakes while the other two sea turtles were likely dead prior to becoming impinged on the intakes. Of the remaining 6 dead sea turtles, only 1 of them had wounds which indicated it may have died prior to becoming impinged at the intakes.

In summary, there have been 41 total observed sea turtles at the OCNGS intakes since 1969, including 27 Kemp's ridleys, 10 loggerheads (which includes 1 recapture), and 4 greens. These numbers include fifteen dead sea turtles (12 Kemp's, 1 green, 2 loggerheads) that have been removed from the intakes at OCNGS since 1992. Based on the best available information, 9 (8 Kemps, 1 green) of the 15 dead sea turtles likely died from drowning or suffocation at the intakes while the remaining 6 sea turtles likely died prior to impingement at the intakes.

Since 1992, the number of sea turtles collected at the OCNGS intakes annually has ranged from zero (1995 and 1996) to a maximum of 8 in 2004. The number of loggerhead annual takes has ranged from zero to 3 (1992), the number of Kemp's ridley annual takes has been from zero to 8 (2004), and the number of green sea turtles collected annually on the intakes ranged from zero to 2 (2000). The number of mortalities has been as high of 3 in 1994 (1 loggerhead, 2 Kemp's ridleys) and 2004 (all Kemp's ridley), while in most other years it has been 1 or zero (with the exception of 2001 when 2 sea turtles were found dead).

The best available information indicates that the operation of OCNGS under the terms of the existing Operating License has had an effect on sea turtles in the action area. In addition to causing the death of at least 9 sea turtles since 1992, it has caused injury to 26 other sea turtles

and has disrupted the migratory movements of these turtles. These turtles have also been subjected to the stress of removal from the water and transfer to a rehabilitation facility.

Non-Federally Regulated Actions

Contaminants and Water Quality

Point source discharges (i.e., municipal wastewater, industrial or power plant cooling water or waste water) and compounds associated with discharges (i.e., metals, dioxins, dissolved solids, phenols, and hydrocarbons) contribute to poor water quality and may also impact the health of sea turtle populations.

Sources of contamination in the action area include atmospheric loading of pollutants, stormwater runoff from coastal development, groundwater discharges, and industrial development. Chemical contaminants may occur in the action area largely as a result of nonpoint source pollution. The Barnegat Bay Estuary Program has data on trace metals and radionuclides in the Barnegat Bay, but other toxic chemical contaminants may also occur in the action area including halogenated hydrocarbons and polycyclic aromatic hydrocarbons (PAHs). The Barnegat Bay estuary may be more susceptible to toxic chemical contaminants than may other estuaries because of its limited dilution capacity and flushing rate (Barnegat Bay Estuary Program 2001).

While the effects of contaminants on turtles are relatively unclear, pollutants may also make sea turtles more susceptible to disease by weakening their immune systems. Chemical contaminants may also have an effect on sea turtle reproduction and survival. Pollution may also be linked to the fibropapilloma virus that kills many turtles each year (NMFS 1997). If pollution is not the causal agent, it may make sea turtles more susceptible to disease by weakening their immune systems.

Excessive turbidity due to coastal development and/or construction sites could influence sea turtle foraging ability. Turtles are not very easily affected by changes in water quality or increased suspended sediments, but if these alterations make habitat less suitable for turtles and hinder their capability to forage, eventually they would tend to leave or avoid these less desirable areas (Ruben and Morreale 1999).

Approximately 28% of the Barnegat Bay watershed is developed (residential, commercial, industrial, and institutional), while 46% is forested land. Barnegat Bay supports a thriving tourist industry, with boating, fishing, swimming, and hunting being top recreational activities. The developed land around the Bay may contribute to marine pollution which may in turn impact sea turtles. Marine debris (e.g., discarded fishing line or lines from boats) can entangle turtles in the water and drown them. Turtles commonly ingest plastic or mistake debris for food.

Private and Commercial Vessel Operations

Private and commercial vessels operate in the action area and have the potential to interact with sea turtles. An unknown number of private recreational boaters frequent coastal waters. These activities have the potential to result in lethal (through entanglement or boat strike) or non-lethal (through harassment) takes of listed species that could prevent or slow a species' recovery.

Collisions with vessels, from both commercial and recreational sources, is a potential contributor to sea turtle mortality in the action area. Fifty to 500 loggerheads and 5 to 50 Kemp's ridley turtles are estimated to be killed by vessel traffic per year in the U.S. (National Research Council 1990). Although some of these strikes may be post-mortem, the data show that vessel traffic is a substantial cause of sea turtle mortality. The Intracoastal Waterway traverses the length of Barnegat Bay, and numerous recreational boaters and commercial fishing boats travel this waterway. The Intracoastal Waterway is maintained at a depth of approximately 2 meters by the Army Corps of Engineers, but the greatest depths in Barnegat Bay of 3 to 4 meters occur along this area. Vessel traffic occurs in the action area, specifically in the thermal plume region that extends from Oyster Creek into Barnegat Bay. As turtles may be in the area where high vessel traffic occurs, the potential exists for collisions with vessels transiting from within the action area into the main waters of Barnegat Bay. At least 3 of the sea turtles impinged at OCNGS likely died due to injuries sustained from propeller wounds and/or a boat strike prior to becoming impinged. As these wounds were relatively fresh, they were likely sustained within the action area. Several other sea turtles had scars indicative of past interactions with boats or propellers; it is impossible to determine whether these interactions occurred within the action area.

Non-Federally Regulated Fishery Operations
Very little is known about the level of listed species take in fisheries that operate strictly in state waters. However, depending on the fishery in question, many state permit holders also hold federal licenses; therefore, section 7 consultations on federal actions in those fisheries address some state-water activity. Impacts on sea turtles from state fisheries may be greater than those from federal activities in certain areas due to the distribution of these species. Nearshore entanglements of turtles have been documented; however, information is not currently available on whether the vessels involved were permitted by the state or by NMFS. NMFS is actively participating in a cooperative effort with the Atlantic States Marine Fisheries Commission (ASMFC) and member states to standardize and/or implement programs to collect information on level of effort and bycatch of protected species in state fisheries. When this information becomes available, it can be used to refine take reduction plan measures in state waters.

A variety of commercial and recreational fisheries occur in the action area, producing valuable input into the local economy. Commercially important finfish and shellfish species occurring in the Barnegat Bay include the American eel, alewife, bluefish, striped bass, summer flounder, winter flounder, weakfish, blue crab, horseshoe crab, and hard clam (Barnegat Bay Estuary Program 2001). Several recreational fisheries exist in the action area as well, most notably for bluefish, striped bass, summer flounder, winter flounder, weakfish, black sea bass, and tautog. Fishing gear has been found to entangle and/or hook sea turtles, which can lead to mortality if the sea turtle cannot surface for air. Throughout their range, sea turtles have been taken in different types of gear, including gillnet, pound net, rod and reel, trawl, pot and trap, longline, and dredge gear. There have been no documented takes of sea turtles in any of the fisheries in Barnegat Bay, but it is not known to what degree the various fisheries interact with turtles. For example, one of the sea turtles impinged at OCNGS has 12 feet of line wrapped around its flipper and was trailing a plastic bucket tied to this line. It is not known whether this line and bucket were related to fishing operations in the action area. However, it is likely that sea turtles in the action area interact and are affected by commercial or recreational fisheries operating in the action area.

Reducing Threats to ESA-listed Sea Turtles
The STSSN is an extensive network of participants along the Atlantic and Gulf of Mexico coasts which not only collects data on dead sea turtles, but also rescues and rehabilitates live stranded turtles. Data collected by the STSSN are used to monitor stranding levels and identify areas where unusual or elevated mortality is occurring. These data are also used to monitor incidence of disease, study toxicology and contaminants, and conduct genetic studies to determine population structure. All of the states that participate in the STSSN tag live turtles when encountered (either via the stranding network through incidental takes or in-water studies). Tagging studies help provide an understanding of sea turtle movements, longevity, and reproductive patterns, all of which contribute to our ability to reach recovery goals for the species. The Marine Mammal Stranding Center (MMSC), located in Brigantine, NJ which participates in the STSSN has routinely been involved in the necropsy of dead turtles and the tagging and release of live turtles which have been impinged or captured at the OCNGS.

Additionally, NMFS has developed and published as a final rule in the Federal Register (66 FR 67495, December 31, 2001), specific sea turtle handling and resuscitation techniques for sea turtles that are incidentally caught during scientific research or fishing activities. Persons participating in fishing activities or scientific research are required to take these measures to help prevent mortality of turtles caught in fishing or scientific research gear.

Summary and Synthesis of the Status of the Species and Environmental Baseline
The purpose of the Environmental Baseline is to analyze the status of the species in the action area. Generally speaking, the status of sea turtle species overall is the same as the status of these species in the action area given their migratory nature. The loggerhead, Kemp's ridley, and green sea turtles likely to be found in the action area are typically small juveniles with the most abundant being the federally threatened loggerhead followed by the federally endangered Kemp's ridley, and green sea turtles. The available information on the impacts does not permit the specific itemization of the numbers of lethal and non-lethal interactions between sea turtles and various activities in the action area. However, available information also does not suggest that the types of activities falling with the definition the environmental baseline are unique to the action area, or that the aggregate impacts of those activities is unique compared to other areas. The lack of information also prevents an estimate of numbers of sea turtles of each species likely to be in the action area, although it is expected to be significantly less than the total population given the broad distribution of each species.

Impacts from actions occurring in the Environmental Baseline for the action area have the potential to impact sea turtles. Despite regulations on fisheries actions, improvements in dredge technologies and improvements in water quality, sea turtles still face numerous threats in this area, primarily from habitat alteration and interactions with fishing gear and dredging operations.

Summary of status of sea turtle species
As noted in the status of the species section, the majority of *loggerhead sea turtles* in the action area are likely to be from the south Florida nesting subpopulation, with the remainder from the northern Florida or Yucatan subpopulations. The South Florida nesting subpopulation is the

largest known loggerhead nesting assemblage in the Atlantic. Nesting totals from beaches used by the South Florida subpopulation suggests that this subpopulation may be decreasing. The northern nesting subpopulation is the second largest loggerhead nesting assemblage in the Atlantic. Nesting data has led the TEWG to conclude that the northern subpopulation is likely declining and at best is stable. While researchers have documented significant increases in loggerhead nesting on seven beaches at Quintana Roo, Mexico, nesting survey effort overall has been inconsistent among the Yucatán nesting beaches and no trend can be determined for this subpopulation given the currently available data. No reliable estimate of the total number of loggerheads in any of the subpopulations or the species as a whole exists.

The *Kemp's ridley* is considered the most endangered sea turtle species with only one major nesting site remaining. While recent population estimates for this species are not available, patterns of Kemp's ridley nesting data suggests that this population is increasing or is at least stable.

Recent population estimates of the number of *green sea turtles* in the western Atlantic are unavailable. The pattern of nesting abundance for this species has shown a generally positive trend since monitoring began in 1989 suggesting that this population may be increasing or is at least stable.

Without more information on the status of these species, including reliable population estimates, it is difficult to speculate about the long term survival and recovery of these species. However, the best available information has led NMFS to make the determinations about species status as stated above.

EFFECTS OF THE ACTION

This section of a Opinion assesses the direct and indirect effects of the proposed action on threatened and endangered species or critical habitat, together with the effects of other activities that are interrelated or interdependent (50 CFR 402.02). Indirect effects are those that are caused later in time, but are still reasonably certain to occur. 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). This Opinion examines the likely effects (direct and indirect) of the proposed action on sea turtles in the action area and their habitat within the context of the species current status, the environmental baseline and cumulative effects.

The proposed action has the potential to affect threatened and endangered sea turtles in several ways: impingement at either the CWS or DWS intake trash racks; capture of free swimming sea turtles in the intake bays; altering the abundance or availability of sea turtle prey items; and altering water quality through the discharge of heated and chlorinated effluent.

Impingement and Capture of Sea Turtles

As explained above, 40 individual sea turtles have been taken at the OCNGS since 1992. Fifteen of these turtles have been found dead. Of the 25 live sea turtles, 11 were swimming freely in the intake bays and were removed from the water with a dip net while the remaining 15 were observed impinged on the trash rack and removed or discovered in the piles of debris removed

from the trash rack by the mechanical rake. Nearly all of the sea turtles have evidence of interaction with the trash racks, including abrasions and bruising which suggests that even the live sea turtles were at least temporarily impinged on the rack or otherwise struggled to remove themselves from the area. There is currently no available data on the distribution of loggerheads, Kemp's ridleys and greens in the action area, in Barnegat Bay or in the coastal waters of New Jersey. This makes it impossible to determine that percentage of sea turtles in the action area that are affected by the operation of OCNGS. It is possible that sea turtles occur in the action area and are able to swim away from the intake bays without being detected and do not become impinged in the intake structure.

It is unclear why sea turtles enter the Forked River and encounter the OCNGS intake structures. In order to be present at the intake bays, live sea turtles must actively swim from Barnegat Bay into the Forked River and continue downstream to the intake bays. As the current velocity does not increase until within several meters of the intakes, it does not appear that sea turtles are subject to inescapable currents in the Forked River which would draw them to the intakes. It has been hypothesized that sea turtles are attracted to the intake screens when prey items such as blue crabs and horseshoe crabs are gathered there. For example, in 1992, a loggerhead removed from the CWS intake bay was released into the discharge canal. Two days later this turtle was recaptured at the CWS intake. This sea turtle would have had to actively swim back to the CWS intake area which suggests that the turtle was attracted to either the ambient conditions in the south fork of the Forked River or to the conditions at the intake trash racks. However, it is possible that the return of this sea turtle to the intake was a coincidence and that the turtle was not particularly attracted to the intake area. While sea turtles have not been documented in the discharge canal, conditions in this area may also be attractive to sea turtles. The warm water discharge may increase the distribution of prey species to the area, and returns of live entrained organisms or dead fish and other material dumped from the traveling screens may provide food for the turtles or scavenging prey species.

As noted above, there was no program in place to monitor the intakes for sea turtles prior to 1992 and it is possible that some number of sea turtles have always occurred in the action area and that they went un-documented. While personnel did not monitor the intakes for sea turtles specifically, various impingement and entrainment observations and studies occurred prior to 1992; no sea turtles were recorded during this time. As the operation of the OCNGS has not changed appreciably since 1969 the onset of turtle captures in 1992 may be due to higher numbers of sea turtles in the action area or some change in ambient conditions that served to attract sea turtles to the intakes (e.g., prey availability). One possible explanation is that the Barnegat Inlet was deepened in 1992. In association with the deepening, the south jetty at the entrance of Barnegat Bay was re-aligned. The combination of these activities provided for a greater volume of water and tidal range in the Barnegat Bay and in the vicinity of Oyster Creek. It has been hypothesized that this change in conditions may have contributed to a greater number of turtles entering the action area.

If maintenance dredging of the Intracoastal Waterway and Barnegat Inlet make the Bay more accessible to turtles, the frequency of impingements at OCNGS may increase after each dredging episode and decrease as the Bay fills with sediment. While difficult to quantify, an increase in

the occurrence of oceanic fronts may have also contributed to an increase in turtles in Barnegat Bay, as Polovina et al. (2000) suggest that turtles use oceanic fronts as migratory and foraging habitat. If a greater number of turtles are in the offshore New Jersey waters as a result of the oceanic patterns and they migrate through the Barnegat Inlet, more sea turtles may be found in the action area. Sea turtles may enter the Barnegat Bay with an increase in waves, winds and tidal prism. The yearly fluctuations may also be attributable to biological factors such as the abundance of prey organisms (e.g., blue crabs, horseshoe crabs) in the vicinity of Oyster Creek.

The sea turtles likely to occur in the action area are too large to pass through the intake trash bars, which are constructed with 6.6 cm wide openings. The BA states that any sea turtle that is smaller than the trash bar opening would pass through the CWS intake trash bars and be transported safely to the water via the same traveling screen system that returns entrained fish and other small organisms. It is unlikely that turtles small enough to fit through the 6.6 cm wide opening will be in the vicinity of the OCNGS, because turtles of that size would not likely occur in inshore embayments, but rather in offshore currents (NMFS and USFWS 1992 and 1997).

As noted above both live and dead sea turtles have been found impinged at the OCNGS in the past, at both the DWS and CWS intakes. No sea turtles have been observed in the discharge canal. As water flow is away from this system, sea turtles would not be vulnerable to impingement or entrainment in the discharge canal. Sea turtles impinged at the intakes may suffocate or drown if they are unable to remove themselves from the trash bars and remain underwater for an extended period of time. At times when there is a heavy debris load at the intakes it may be more difficult for a sea turtle to remove itself from the trash bars. If sea turtles impinged on the trash bars are removed in time they may survive the impingement. Plant personnel estimated that many of the turtles that were taken at OCNGS had been impinged for up to 8 hours. In some natural situations, turtles may remain submerged for several hours. However, stress dramatically decreases the amount of time a turtle can stay submerged.

Under conditions of involuntary or forced submergence, sea turtles maintain a high level of energy consumption, which rapidly depletes their oxygen store and can result in large, potentially harmful internal changes (Magnuson et al. 1990). Those changes include a substantial increase in blood carbon dioxide, increases in epinephrine and other hormones associated with stress, and severe metabolic acidosis caused by high lactic acid concentrations. In forced submergence, a turtle becomes exhausted and then comatose; it will die if submergence continues. For example, trawl times for shrimpers in the southeast are limited by regulation to 55 minutes in the summer months and 75 minutes in the winter months, due to the fact that there is a strong positive correlation between tow time (i.e., forced submergence) and incidence of sea turtle death (Henwood and Stuntz 1987, Stebenau and Vietti 2000). Physical and biological factors that increase energy consumption, such as high water temperature and increased metabolic rates characteristic of small turtles, would be expected to exacerbate the harmful effects of forced submergence. Other factors, such as the level of dissolved oxygen in the water, the activity of the turtle and whether or not it has food in its stomach, may also affect the length of time it may stay submerged. It is likely that sea turtles impinged on the intake trash bars are already stressed; these conditions may increase the turtles' susceptibility to suffocation or drowning.

Nearly all of the sea turtles removed from OCNGS, including those recovered alive, have had evidence of injury sustained from contact with the trash bars. Typically this injury has been abrasions or bruising. Sea turtles may also be subject to injury from the operation of the trash rake which removes debris from the intake trash bars. The rake, a horizontal array of large curved tines, is lowered down into the bay to remove debris from the intake gratings. When the rake reaches the desired depth, the tines are deployed, curving downward to penetrate through the grate before the rake is raised. This process could cause serious injury to a turtle. Scrapes on a turtle's carapace could also result from interactions with the intake trash bars, or during rescue and retrieval by OCNGS personnel. Scrapes have been observed the carapace of several sea turtles removed from the intakes. Additionally, two of the sea turtles have had puncture wounds near the base of their necks which may be indicative of interactions with the tines of the trash rake.

The maximum number of turtles collected at OCNGS in one year was eight Kemp's ridleys (in 2004). In other years, the number has ranged from zero to 6. Physical and biological factors may have played a role in attracting more turtles to the vicinity of OCNGS in 2004. As mentioned in the BA, oceanic water temperatures were slightly higher during 2004 than in previous years. The NRC states that based on information provided from the National Weather Service, the average ocean water temperatures during the summer of 2004 were 1.4°C above normal. This increase in water temperature may have been a factor attracting juvenile sea turtles to the waters of the mid-Atlantic searching for foraging and developmental habitats. Therefore, the increased water temperatures observed in Atlantic waters during the summer of 2004 may be a factor contributing to the high number of Kemp's ridley sea turtles taken at OCNGS that year. It is interesting to note that only 2 sea turtles were found at the OCNGS in 2005. The number of sea turtles at the facility likely reflects annual environmental fluctuation in the action area, such as water temperature, the proximity of the Gulf Stream, storm activity, and the quality and quantity of prey in the area.

All of the sea turtles at OCNGS have been collected between June and October. This is consistent with the presumption that because of seasonal fluctuations of water temperatures, loggerhead, Kemp's ridley, and green sea turtles only occur in the action area during this time period. As sea turtles are only likely to occur in the action area from June through October, it is reasonable to anticipate that impacts of the OCNGS on listed species will only be observed from June through October. The majority of sea turtles have been collected in July, followed by September. This may be reflective of the migratory nature of these species as they move up the coast in early summer and move back down the coast in the fall. There does not seem to be any discernible pattern in month by month species distribution.

More Kemp's ridleys are caught at OCNGS than loggerheads and greens, which is noteworthy, as there are thought to be more loggerheads than Kemp's ridleys in New Jersey waters. Kemp's ridleys may be more likely to become impinged in the intake structures due to their physiology and behavioral characteristics. Swimming efficiency is likely related to the size of a turtle, with larger turtles having a stronger swimming ability than smaller turtles. As such, it is possible that because the Kemp's ridleys and greens found impinged at OCNGS are generally smaller than the loggerheads they were not able to effectively escape the intake velocity. Of the 41 turtles found

at OCNGS from 1992 to 2006, 26 of these turtles were found alive, and 15 were dead. Of the 10 loggerheads taken, 8 were alive at the time of the take. The remaining 2 turtles had necropsies completed which indicated that the loggerheads died prior to becoming impinged on the intakes. Of the 4 green sea turtles, only 1 was dead. While necropsy results are not available for this turtle, the lack of apparent injury or infection suggest it likely drowned or suffocated due to impingement. Of the 26 Kemp's ridleys taken to date, 12 were dead when removed from the intakes. Necropsies conducted on 2 Kemp's ridleys indicate they likely died prior to impingement on the intakes. Of the 10 remaining dead Kemp's ridleys, necropsy results confirmed that 2 died from suffocation or drowning at the intakes. The lack of noticeable injury or signs of decomposition suggest that 7 additional Kemp's also died from suffocation or drowning at the intakes. The remaining turtle was partially decomposed when removed from the intakes, suggesting that it died prior to becoming impinged. This information suggests that once at the intakes, Kemp's ridleys are more susceptible to death due to drowning or suffocation than loggerhead or green sea turtles.

The ability of a given turtle to swim against the current at either the CWS or DWS intake and the condition at time of capture could depend on the species, size, relative health of each individual, or the particular conditions associated with each take (e.g., water temperature, duration of submergence time, etc.). Kemp's ridleys cannot survive underwater as long as other sea turtle species, as they have been found to drown faster in trawl nets compared to other species (Magnuson et al. 1990). A turtle weakened by disease or injured by a boat strike would be more susceptible to impingement if the velocity at the intake is a factor in the likelihood of impingement. Many of the sea turtles found impinged on the intake trash bars at OCNGS have previously been victims of collision with propellers. In several cases the wounds appear to be fresh, which may be a contributing factor to the impingement, as the sea turtle would be weak.

The 10 individual loggerhead turtles incidentally captured at OCNGS had an average straight carapace length (SCL) of 43.05 cm. The 26 Kemp's ridleys and 4 green turtles had an average SCL of 27.8 cm and 29.8 cm, respectively. As discussed above, smaller sea turtles are subject to a greater amount of stress if caught in an intake, as they have a lower swimming ability. The smaller size of the Kemp's ridley sea turtles found at OCNGS in combination with the increased susceptibility to drowning noted by Magnuson et al. (1990) may explain why this species seems to be more vulnerable to death at the intakes than the other species.

As noted above, sea turtles have been collected and impinged at both the CWS and DWS intakes. Of the 41 sea turtles collected from 1992 to 2004, 25 (61%) have occurred at the DWS intake and 16 (39%) at the CWS intake. From 1992 to 2006, 6 of 10 loggerheads (60%) captured at OCNGS have been retrieved from the CWS intake, while only 9 of the 26 Kemp's ridleys (35%) have been found at the CWS intake. The loggerheads incidentally captured have been generally larger than the Kemp's ridleys, and the larger size of the loggerheads could result in more efficient swimming ability, allowing the animal to move around the floating ice/debris barrier and end up at the CWS intake. If Kemp's ridley and green turtles were found close to the surface and lacking the swimming ability or strength to dive beneath the floating ice/debris barrier, they would be channeled to the DWS intake. These species' prey are typically found on the bottom

(e.g., crustaceans, marine grasses), which would suggest that they would not be on the surface if they were foraging.

Of the 15 dead sea turtles, 14 have been found at the DWS, with 56% of the sea turtles found at the DWS dead. This compares to approximately 6% of the sea turtles at the CWS found dead. This difference may be attributable to a number of factors but is most likely related to the presence of the debris/ice barrier which diverts floating debris away from the CWS intake and towards the DWS intake. A turtle that swims or drifts on the surface toward the OCNGS intakes may be turned towards the DWS by the floating wooden debris/ice barrier. The orientation of the barrier may result in turtles at the surface being funneled toward the DWS. However, there are gaps on either end which a turtle could easily swim through and the barrier only extends 2 feet below the surface, so a healthy turtle could easily swim under the barrier and turn left towards the CWS intake. Additionally, the intake velocity at the DWS is considerably higher than that of the CWS intake. This could make it more difficult for sea turtles to free themselves from the trash bars and increase the likelihood of drowning once impinged. The presence of a greater amount of grasses and other debris at the DWS may also make it more difficult for sea turtles to free themselves from the trash bars and may make it more difficult for plant personnel to spot sea turtles here and remove them from the trash bars in time to prevent drowning. More Kemp's ridleys and greens have been found at the DWS than loggerheads, as these species have been found to have an overall smaller average carapace length than the loggerheads, they may be more susceptible to drowning due to their smaller size and lower swimming ability, especially when stressed. It is also likely that any previously dead sea turtles that float into the area would be diverted to the DWS intake and be discovered there.

As noted above, not all of the dead sea turtles collected at OCNGS died as a result of the operation of the facility. However, as only some of the dead sea turtles have been necropsied, it is difficult to definitively determine the cause of death for many of these turtles. As explained above, of the 15 dead sea turtles, necropsy results indicated that 4 of the sea turtles were dead prior to becoming impinged. Signs of decomposition and injury suggest that an additional 2 sea turtles may also have been dead prior to becoming impinged. The cause of death for the other 9 sea turtles is likely suffocation or drowning at OCNGS, with 2 of these confirmed by necropsy.

In addition to injury and mortality, impingement at the OCNGS intake could result in the interruption of migration and the eventual loss of nesting opportunities. Sea turtles migrate to northeastern waters when the waters warm in the late spring and early summer, returning south in the late fall. While turtles may be in the action area for foraging purposes, it is possible that turtles are migrating through the area in the spring on their way to more suitable foraging habitats in the Northeast, or in the fall on their way to overwintering areas. If interactions at the OCNGS impedes normal behaviors, this would affect typical sea turtle migration and/or foraging patterns. Most of the sea turtles found at OCNGS are juveniles and are not yet partaking in nesting. However, if impingement results in mortality, these animals would not nest in the future and would not subsequently contribute to the population.

The proposed action, renewal of the Operating License for the OCGNS for an additional 20 years, will not cause any operational changes at the CWS or DWS intakes that are likely to cause

a different rate of impingement or capture of sea turtles than has been observed in the past. As noted above, the number of sea turtles in the action area is likely variable each year depending on environmental factors such as water temperature, weather patterns and prey availability and may also be related to dredging and shoaling actions in Barnegat Bay. Based on the best available information, NMFS anticipates that up to 8 sea turtles are likely to be impinged or collected at the OCNGS intakes each year. The majority of these sea turtles are likely to continue to be Kemp's ridleys; and, in some years, as was seen in 2004, all of the sea turtles at OCNGS may be Kemp's ridleys. It is likely, based on past observations, that zero to 1 green sea turtle is likely to be collected at OCNGS each year and up to 2 loggerheads will be collected. However, NMFS anticipates that no more than 8 sea turtles will be impinged on the intakes or observed swimming in the intake bays and removed from the water.

Based on the observation of sea turtles captured at the facility in the past, it is likely that nearly all of the sea turtles captured will suffer from some degree of injury, likely abrasions and bruising, due to interactions with the trash bars. However, if rescued alive, these injuries are not expected to be life threatening and sea turtles are expected to make a complete recovery.

NMFS anticipates that sea turtles will continue to die due to suffocation and drowning caused by impingement on the trash bars. Based on numbers of sea turtles observed at OCNGS in the past, up to 3 dead sea turtles are likely to be removed from the facility each year. Over the license period, the majority of these dead sea turtles are likely to be Kemp's ridleys and in some years it is likely that all of the dead sea turtles will be Kemp's ridleys; however, in any year, up to 2 of these dead sea turtles may be loggerheads and 1 may be a green sea turtle. While NMFS recognizes that some number of previously dead sea turtles may become impinged on the intake trash bars each year, the difficulty in definitively determining a cause of death and the inconsistency in the applicant's ability to obtain necropsy results for dead sea turtles, makes it difficult to accurately predict the number of previously dead sea turtles that will become impinged on the intakes each year. As such, NMFS anticipates that the 3 dead sea turtles may, in some years, include sea turtles that died prior to becoming impinged on the OCNGS intakes.

Based on the analysis above, NMFS anticipates that over the course of the 20 year life of the license, up to 160 sea turtles may be impinged or removed from the intake area, with up to 60 of these sea turtles being dead.

Effects on Prey

Significant numbers of aquatic organisms besides sea turtles are also impinged at the CWS and DWS intakes and large volumes of small organisms are entrained at both intakes. It has been hypothesized that sea turtles are attracted to the intakes due to the high concentration of sea turtle forage items, particularly blue crabs, horseshoe crabs and sea grasses, which are found at the intakes.

In addition to concentrating sea turtle forage items at the intakes, the operation of the OCNGS intakes causes a large number of potential sea turtle prey items to be lost each year. Several of the species subject to impingement and entrainment at the OCNGS are potential prey for sea turtles, including blue crabs, hard clams and several shrimp species. Recent data on rates of

impingement and entrainment are not available. However, studies reviewed by the NJ DEP (NJDEP draft NPDES permit 2005) indicate that the equivalent of 59,000 adult hard clams and 10,400 blue crabs are lost to impingement and entrainment each year. This represents a large number of organisms that are no longer available for sea turtles to prey upon in the action area. In addition to clams and crabs, several million shrimp and fish are also subject to impingement and entrainment at the facility each year. While the OCNGS causes the death of many thousands of potential sea turtle forage items each year, the effect of this loss of prey on sea turtles in the action area is unknown; however, there is no evidence that sea turtles in the action area are affected by a reduction in the availability of forage items. For example, sea turtles removed from the intakes display no evidence of starvation or other indications of a lack of quality forage. Additionally, if sea turtles were limited by available forage items in the action area, it is likely that numbers of sea turtles at the OCNGS would be decreasing when in fact the numbers show an increasing trend. Based on the best available information, while the OCNGS reduces the amount of sea turtle forage items available for sea turtles in the action area, this loss appears to be insignificant to sea turtles in the action area.

Effects on Water Quality

The water quality of effluents discharged from the OCNGS is regulated through the New Jersey Pollution Discharge Elimination System (NJPDES) program. The NJDPES permit specifies the discharge standards and monitoring requirements for each discharge. Under this regulatory program, AmerGen treats wastewater effluents, collects and disposes of potential contaminants, and undertakes pollution prevention activities.

The NJPDES permit for this facility was last issued in 1994. This permit expired in 1999 and has been administratively extended each year. A draft permit was submitted for public comment in July 2005. To date, no action has been taken on the draft permit and the facility is still operating under the terms of the 1994 permit. As such, the effects of the OCGNS continuing to operate under the terms of the 1994 permit will be discussed below.

Impacts of chlorine used at the OCNGS

Low level, intermittent chlorination is used to control biofouling in the OCNGS service water system and circulating water systems. The main condenser cooling water is chlorinated for a maximum of two hours per day. The permitted maximum daily concentration of chlorine discharge is 0.2 mg/l or a maximum daily chlorine usage of 41.7 kg/day. The NRC has stated that the chlorine demand in the main condenser discharge consumes almost all remaining free chlorine and results in very little chlorine being released to the discharge canal (approximately 0.1 mg/l). The DWS does not have any chlorine discharges.

Chemical contaminants have been found in the tissues of sea turtles from certain geographical areas. While the effects of chemical contaminants on turtles are relatively unclear, they may have an effect on sea turtle reproduction and survival. Chemical contaminants may also affect the immune system, making sea turtles more susceptible to disease and other stresses. There is no information available on the effects of chlorination on sea turtles. It is also unknown as to whether the sea turtles impinged at OCNGS had appreciable levels of chlorine in their tissues.

The necropsies conducted on the sea turtles found at the OCNGS did not assess the levels of contaminants in the tissue.

There are a number of studies that have examined the effects of Chlorine Produced Oxidants (also referred to as Total Residual Chlorine or TRC) on aquatic life (Post 1987; Buckley 1976); however, no directed studies that have examined the effects of CPO on sea turtles have been conducted. The EPA has set the Criteria Maximum Concentration[3] for exposure to chlorine at 0.019mg/L.

As noted above, the daily maximum "end-of-pipe" concentration (i.e., the concentration of TRC in the effluent as it discharges into the receiving water) allowed by the permit is 0.2mg/L. The anticipated TRC level at the point of discharge is significantly higher than EPA's ambient water quality criteria and higher than chlorine levels known to be protective of aquatic life. The chlorinated water is mixed with unchlorinated water from the DWS system at the point of discharge and is rapidly diluted before it enters Barnegat Bay, the area where the highest number of sea turtles are likely to be present. It is also important to note that elevated chlorine levels are not known to occur at the CWS and DWS intakes where sea turtles are likely to be present for extended periods of time, but only at the discharges where sea turtles have not been observed. Based on the best available information, due to the rapid dilution of chlorinated effluent, the level of chlorination at the OCNGS is believed to have an insignificant effect on sea turtles in the action area.

The chlorine discharge may also have an effect on sea turtle forage items. Chlorine is used in the plant as a biocide, and the discharge of this chemical could kill sea turtle forage items or cause them to leave the area, thus reducing the number available to sea turtles. However, as explained above, there is no indication that sea turtles in the action area are limited by the amount of available forage. Additionally, blue crabs, one of the main forage items for sea turtles in the action area, are relatively insensitive to chlorine levels. For example, EPA has reported LC50 levels for blue crabs of 0.7 – 0.86mg/L (EPA 1986). Based on the best available information, while the discharge of chlorinated effluent may affect individual sea turtle forage items, the level of chlorination at the OCNGS is believed to have an insignificant effect on the ability for sea turtles to forage successfully in the action area.

Heated Effluent

Heated condenser cooling water discharged from the CWS and ambient temperature intake canal water discharged from the DWS meet and mix in the discharge canal and are returned to Barnegat Bay via this canal. This process results in heated discharge water mixing with the ambient water and elevating the normal water temperatures. The NJPDES permit for this facility limits the discharge of heated effluent to an instantaneous maximum of 41.1°C or 12.8°C above ambient. The temperature rise of the CWS discharge is typically about 11°C above ambient canal temperatures, while the DWS discharge is approximately 5.6°C above ambient water temperatures when two dilution pumps are operating.

3 CMC or acute criteria; defined in 40 CFR 131.36 as equals the highest concentration of a pollutant to which aquatic life can be exposed for a short period of time (up to 96 hours) without deleterious effects

The impacts of the thermal plume in Barnegat Bay appear to be on the surface and relatively small, thus reducing the potential for negative affects to sea turtles. The cooling water discharged from OCNGS has been studied on several occasions to determine the distribution, geometry, and dynamic behavior of the thermal plume (OCNGS 2000). While the discharge temperature near OCNGS is high, the turbulent dilution mixing produces rapid temperature reductions. Little mixing with the heated discharge and ambient water occurs in Oyster Creek from the site of the discharge to the Bay, because of the relatively short residence time and the lack of turbulence or additional dilution. However, in Barnegat Bay, temperatures are rapidly reduced when mixing with ambient temperature Bay water occurs as well as heat rejection into the atmosphere. In Barnegat Bay, the plume occupies a relatively large surface area (estimated to be less than 1.6 km in an east-west direction by 5.6 km in a north-south direction, under all conditions) and in general, elevated temperatures do not extend to the bottom of the Bay except in the area immediately adjacent to the mouth of Oyster Creek. While the plume in Barnegat Bay is on the surface, it may impact sea turtles as they are coming up for air.

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. Environmental temperatures above 40°C can result in stress for green sea turtles (Spotila et al. 1997). Sea turtle eggs exposed to temperatures to temperatures above 38°C typically fail to hatch (Bustard and Grehan 1967). As noted above, the daily maximum "end-of-pipe" temperature is 41.1°C. However, the maximum temperatures recorded in the discharge canal were 38°C during a dilution pump failure event in 2002. It is also important to note that elevated temperature is not known to occur at the CWS and DWS intakes where sea turtles are likely to be present for extended periods of time, but only at the discharges where sea turtles have not been observed. Based on the best available information, the discharge of heated effluent may affect sea turtles by attracting them to the area or increasing the amount of potential prey but does not likely cause any injury or mortality.

While sea turtles will not likely be killed by the elevated temperatures, temperature increases may affect normal distribution and foraging patterns. The thermal effluent discharged from the plant into Oyster Creek may represent an attraction for turtles. If turtles are attracted into Oyster Creek by this thermal plume, they could remain there late enough in the fall to become cold-stunned when they finally travel into Barnegat Bay at the start of their southern migration. 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 concentrated around the heated discharge or in surrounding waters heated by the discharge (e.g., Oyster Creek or Barnegat Bay) and move outside of this plume into cooler waters (approximately less than 8-10°C), they could become cold stunned. However, existing data from OCNGS and other 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. Data reported by the STSSN indicate that cold-stunning has occurred around mid-November in New York waters. No incidental captures of sea turtles have been reported at the OCNGS later than October, with the minimum recorded temperature at time of capture of 11.8°C, suggesting that sea turtles leave the action area before cold-stunning could potentially occur.

While cold stunning could still occur given the heated discharge and the water temperatures in New Jersey during certain times of the year (e.g., less than 10°C), NRC has identified certain aspects of the OCNGS discharge that may make cold stunning less likely to occur. For example, the area where sea turtles could overwinter (and encounter acceptable water temperatures) is limited to the small area around the condenser discharge, prior to any mixing with the DWS flow. Winter water temperatures in the discharge canal, downstream of the area where the DWS and CWS flows mix, routinely fall below 7.2°C. These temperatures in the discharge canal would not be suitable for sea turtle survival. Sea turtles generally are found in water temperatures greater than 10°C, but have occasionally been documented in colder waters. For example, in March 1999, a live loggerhead sea turtle was observed taken on a monkfish gillnet haul in North Carolina, in a water temperature of 8.6°C. In any event, during the winter, the area where the water temperatures would be suitable for sea turtles is small and localized. Based on the best available information, there is no evidence that the discharge of heated effluent increases the vulnerability of sea turtles in the action area to cold stunning.

Effect on Sea Turtle Prey
Cold shock mortalities of fish have occurred at OCNGS when water temperatures have decreased in the fall. There is no evidence that sea turtles have been adversely affected by any mass mortality of fish or that sea turtle prey have been impacted by cold shock events. The number and severity of these events have been reduced as a result of the operation of the two dilution pumps in the fall, when ambient water temperatures began to drop, to decrease the attractiveness of the discharge canal as overwintering habitat. As mentioned, cold stunning of sea turtles has not been documented at OCNGS, but the measures to reduce cold shock mortalities of fish would also help reduce the potential for cold stunning of sea turtles.

Heat shock events have also been recorded at OCNGS. For example, on September 23, 2002, 5876 fish were killed. NRC reports that the mortality was attributed to heat shock because of an accidental shutdown of the dilution pumps during a routine electrical maintenance procedure. During that event, the water temperature in the discharge canal rose from approximately 32.8°C to 38.3°C within 3 hours of pump shutdown and the temperature at this location remained at 37.8°C for several hours until the dilution pump operation was restored. High temperatures recorded during this event are the highest temperatures on record for the action area. There is no evidence that any sea turtles were in the impact area during this event.

The thermal discharges from OCNGS may influence the distribution and survival of sea turtles' primary prey resources. Blue crab and horseshoe crab are found in the canal, generally during the warmer months, but the effect of the heated effluent on the distribution of these species is uncertain. Crustaceans may move elsewhere when conditions are unfavorable (e.g., elevated water temperatures), but there is no information at this time suggesting that this has occurred at OCNGS. It is probable that when sea turtles are foraging in the summer, the heated effluent will not have as great of an impact on the turtles as it would in the winter. Furthermore, the New Jersey DEP evaluated the impact of the OCNGS thermal plume on Barnegat Bay and concluded that the effects on fish distribution and abundance were small and localized (Summers et al. 1989 in OCNGS 2000). Thus, it appears that the preferred prey of loggerhead, Kemp's ridleys, and

greens are impacted insignificantly, if at all, by the thermal discharge from OCNGS and that there are no significant impacts on the ability of sea turtles to forage due to this discharge.

CUMULATIVE EFFECTS

Cumulative effects, as defined in 50 CFR 402.02, are those effects of future state or private activities, not involving federal activities that are reasonably certain to occur within the action area of the federal action subject to consultation. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Natural mortality of sea turtles, including disease (parasites), predation, and cold-stunning, occurs in mid-Atlantic waters. In addition to impingement in the OCNGS intakes, sources of human-induced effects on turtles in the action area include incidental takes in state-regulated fishing activities, vessel collisions, ingestion of plastic debris, and pollution. While the combination of these unrelated, non-federal activities in Barnegat Bay may adversely affect populations of endangered and threatened sea turtles.

NMFS believes that the fishing activities in Barnegat Bay will continue in the future, and as a result, sea turtles will continue to be impacted by fishing gear used in the action area. Throughout their range, sea turtles have been taken in different types of gear, including gillnet, pound net, rod and reel, trawl, pot and trap, longline, and dredge gear. Thus, it is likely that commercial and recreational fisheries in the action area will continue to impact sea turtles, albeit to an unknown extent.

Commercial and recreational vessels colliding with sea turtles will also continue in the future, and sea turtles will continue to be injured or killed from these interactions. Fifty to 500 loggerheads and 5 to 50 Kemp's ridley turtles are estimated to be killed by vessel traffic per year in the U.S. (National Research Council 1990). Although some of these strikes may be post-mortem, the data show that vessel traffic is a substantial cause of sea turtle mortality. As turtles will likely be in the area where high vessel traffic occurs, the potential for collisions with vessels transiting these waters exists. The MMSC in Brigantine, New Jersey, reports an increase in the number of turtles hit by boats in New Jersey inshore and nearshore waters, as determined from sea turtle stranding records.

Twenty-eight percent of the land around Barnegat Bay is developed. In the future, a larger amount of the watershed will likely be developed because Barnegat Bay supports a thriving tourist industry and more individuals are moving to the coast in general. An increase in boating, fishing, and general use of the Bay is also likely to occur. With this increase in development and utilization of the Bay, there is a greater potential for debris and pollutants to enter the waters of the action area. Sea turtles will continue to be impacted by pollution in the Bay and any increase in debris or pollutants would exacerbate this effect. Marine debris (e.g., discarded fishing line or lines from boats) can entangle turtles in the water and drown them. Turtles commonly ingest plastic or mistake debris for food. Storm water runoff and other sources of nonpoint source pollution may result in the waters containing chemical contaminants. The Barnegat Bay estuary may be more susceptible to toxic chemical contaminants than may other estuaries because of its

limited dilution capacity and flushing rate (Barnegat Bay Estuary Program 2001). Chemical contaminants may have an effect on sea turtle reproduction and survival, but the impacts are still relatively unclear.

INTEGRATION AND SYNTHESIS OF EFFECTS

NMFS has estimated that the proposed action, the renewal of the Operating License for the OCNGS for twenty years, is likely to result in the collection of up to 8 sea turtles a year due to impingement on the CWS and DWS intakes and capture by plant personnel. The sea turtles captured at the facility are likely to be loggerhead, Kemp's ridley and green sea turtles. All of the sea turtles removed from the intakes are likely to have been injured due to interactions with the trash bars. NMFS expects that no more than 2 of the sea turtles annually will be loggerheads (1 dead) and no more than 1 annually will be green (alive or dead). Further, NMFS anticipates that no more than 3 of Kemp's ridleys will be dead. As explained in the "Effects of the Action" section, effects of the facility on sea turtle prey items and the effect of the discharge of pollutants, including chlorine and heat, will be insignificant or discountable.

Kemp's ridley sea turtles. Kemp's ridleys are endangered throughout their entire range. As explained in the "Effects of the Action" section, NMFS has estimated that up to 8 Kemp's ridley sea turtles are likely to be collected, impinged and injured at the OCNGS each year, with no more than 3 dead Kemp's ridleys at the plant annually. The death of up to 3 Kemp's ridleys every year will reduce the number of Kemp's ridleys as compared to the number of Kemp's ridleys that would have been present in the absence of the proposed action. This level of capture, injury and mortality is likely to occur annually throughout the 20 year license period.

The most recent population estimate for Kemp's ridleys indicates that there were approximately 3,000 adults in 1995. While more recent population estimates do not exist, the size of the population is thought to be increasing, or at least stable, and as the 1995 estimate includes only adults, the size of the total population is likely significantly higher than 3,000. The action may injure up to 8 Kemp's ridleys a year and may kill up to 3 Kemp's ridleys a year, for a total of up to 160 injured and up to 60 killed over the twenty year life of the license. The loss of 3 Kemp's ridleys annually, or up to 60 over 20 years, represents a very small percentage of the species as a whole and is unlikely to have a detectable effect on the numbers or reproduction of Kemp's ridleys. While the loss of a small number of individuals from a subpopulation or species may have an appreciable reduction on the numbers, reproduction and distribution of the species, in general this is likely to occur only when there are very few individuals in a population, the individuals occur in a very limited geographic range or the species has extremely low levels of genetic diversity. This situation is not likely in the case of Kemp's ridleys because: the species is widely geographically distributed, it is not known to have low levels of genetic diversity, there are several thousand individuals in the population and the number of Kemp's ridleys is likely to be increasing and at worst is stable.

This action is not likely to reduce distribution of Kemp's ridleys because the action will only temporarily disrupt migratory behaviors. In addition, as the action is not likely to have a detectable effect on the numbers or reproduction of Kemp's ridleys, it is unlikely to affect the distribution of sea turtles in U.S. waters or throughout the range of the species. For these

reasons, NMFS believes that there is not likely to be any detectable reduction in reproduction and distribution and only a small decrease in the numbers of Kemp's ridleys in the U.S. Atlantic. As such, there is not likely to be an appreciable reduction in the likelihood of survival and recovery in the wild of this species.

Loggerhead sea turtles. Loggerheads are threatened throughout their entire range. This species exists as five subpopulations in the western Atlantic that show limited evidence of interbreeding. As noted in the "Status of the Species" section (see p. 17), loggerheads in the action area are likely to be from the northern nesting subpopulation. Although the northern nesting subpopulation produces about 9 percent of the total loggerhead nests, they comprise more of the loggerhead sea turtles found in foraging areas from the northeastern U.S. to Georgia: between 25 and 59 percent of the loggerhead sea turtles in this area are from the northern subpopulation (Sears 1994, Norrgard 1995, Sears et al. 1995, Rankin-Baransky 1997, Bass et al. 1998). The northern subpopulation may be experiencing a significant decline (2.5 - 3.2% for various beaches) due to a combination of natural and anthropogenic factors, demographic variation, and a loss of genetic viability.

As explained in the "Effects of the Action" section, NMFS has estimated that up to 2 loggerhead sea turtles are likely to be captured or impinged and injured annually at the OCNGS, with no more than 1 dead loggerhead turtle at the facility annually, for a total of up to 40 injured and up to 20 killed over the twenty year life of the license.

The death of 1 loggerhead every year, or up to 20 over 20 years, will reduce the number of loggerheads from the respective subpopulation as compared to the number of loggerheads that would have been present in the absence of the proposed action. The deaths of these loggerheads would have the most impact if these turtles were all juvenile females from the northern subpopulation. While nearly all of the loggerheads affected by this action are likely to be juveniles, they are not all likely to be females from the northern subpopulation as not all of the turtles killed will be females and only 25-59% of the loggerheads in the action area are likely to be from the northern subpopulation. Based on the information outlined above, it is likely that less than half of the turtles in the action area will be from the south Florida subpopulation and the remainder from the northern Florida and Yucatan subpopulations.

There are at least five western Atlantic loggerhead subpopulations (NMFS SEFSC 2001; TEWG 2000; Márquez 1990). As noted above, cohorts from three of these populations, the south Florida, Yucatán, and northern subpopulations, are likely to occur in the action area for this consultation. The south Florida nesting group is the largest known loggerhead nesting assemblage in the Atlantic and one of only two loggerhead nesting assemblages worldwide that has greater than 10,000 females nesting per year (USFWS and NMFS 2003; USFWS Fact Sheet). Annual nesting totals have ranged from 48,531 - 83,442 annually over the past decade (USFWS and NMFS 2003). The northern subpopulation is the second largest loggerhead nesting assemblage within the U.S. but much smaller than the south Florida nesting group. The number of nests for this subpopulation has ranged from 4,370 - 7,887 for the period 1989-1998, for an average of approximately 1,524 nesting females per year (USFWS and NMFS 2003). The Yucatán nesting group was reported to have had 1,052 nests in 1998 (TEWG 2000).

While reliable estimates of the total size of either subpopulation do not exist, as each subpopulation also includes juveniles and males, the size of each subpopulation is likely to be significantly larger than the number of nesting females.

The loss of 1 loggerhead every year, or up to 20 over the 20 year license, from any subpopulation represents a very small percentage of either the subpopulation or the species as a whole and is unlikely to have a detectable effect on the numbers or reproduction of the affected subpopulation. While the loss of a small number of individuals from a subpopulation or species may have an appreciable reduction on the numbers, reproduction and distribution of the species, in general this is likely to occur only when there are very few individuals in a population, the individuals occur in a very limited geographic range or the species has extremely low levels of genetic diversity. This situation is not likely in the case of loggerheads because: the species is widely geographically distributed, it is not known to have low levels of genetic diversity, and in the case of the northern and south Florida subpopulations there are thousands of nesting females.

This action is not likely to reduce the distribution of loggerheads because the action will only temporarily disrupt migratory behaviors. In addition, as the action is not likely to have an appreciable effect on the numbers or reproduction of loggerheads, it is not likely to affect the distribution of sea turtles in the five subpopulations or throughout the range of the species. For these reasons, NMFS believes that there is not likely to be any reduction in reproduction and distribution and only a small decrease in the numbers of loggerheads in the western Atlantic subpopulations. As such, there is not likely to be an appreciable reduction in the likelihood of survival and recovery in the wild of the western Atlantic subpopulations or the species as a whole.

Green sea turtles. Green sea turtles are endangered throughout their entire range. As explained in the "Effects of the Action" section, NMFS has estimated that 1 green sea turtle is likely to be impinged or captured and injured or killed at the OCNGS each year, and up to 20 greens are likely to be injured or killed over the 20 year license period. The death of 1 green every year, or up to 20 over 20 years, will reduce the number of greens as compared to the number of greens that would have been present in the absence of the proposed action. This level of capture, injury and mortality is likely to occur annually throughout the 20 year license period.

Recent population estimates for the western Atlantic area are not available. However, the pattern of green turtle nesting shows biennial peaks in abundance, with a generally positive trend during the ten years of regular monitoring since establishment of index beaches in 1989. There is cautious optimism that the green sea turtle population is increasing in the Atlantic. For purposes of this consultation, NMFS will assume that the green sea turtle population is increasing (best case) or at worst is stable. The loss of 1 green sea turtle annually, and up to 20 over 20 years, represents a very small percentage of the species as a whole and is unlikely to have a detectable effect on the numbers or reproduction of greens. While the loss of a small number of individuals from a subpopulation or species may have an appreciable reduction on the numbers, reproduction and distribution of the species, in general this is likely to occur only when there are very few individuals in a population, the individuals occur in a very limited geographic range or the

species has extremely low levels of genetic diversity. This situation is not likely in the case of greens because: the species is widely geographically distributed, it is not known to have low levels of genetic diversity, there are several thousand individuals in the population and the number of greens is likely to be increasing and at worst is stable.

This action is not likely to reduce the distribution of greens because the action will only temporarily disrupt migratory behaviors. In addition, as the action is not likely to have an appreciable effect on the numbers or reproduction of greens, it is not likely to affect the distribution of sea turtles throughout the range of the species. For these reasons, NMFS believes that there is not likely to be any reduction in reproduction and distribution and only a small decrease in the numbers of greens in the US Atlantic. As such, there is not likely to be an appreciable reduction in the likelihood of survival and recovery in the wild of the species as a whole.

If NRC did not renew the OCNGS Operating License, AmerGen would cease plant operations by the end of the current license (April 9, 2009) and initiate decommissioning of the plant. Decommissioning would involve removal of the intake structures and the elimination of water withdrawals and discharges. As such, if the Operating License was not renewed and the plant was decommissioned, the potential for direct and indirect effects on sea turtles would be eliminated. NRC has indicated that should the license not be renewed there would be a need for the development of an alternate source of electricity for the power users. To fill the energy deficit created by the decommissioning of the OCNGS, the site could be redeveloped as a coal-fired, natural-gas-fired or new nuclear power plant. Any of these types of plants could also be constructed at an alternative site. The magnitude of impacts to NMFS listed species would be determined by the type and location of any alternative facility and would have to be analyzed based on the particulars of the plan. As such, it is not possible to predict the impacts of redeveloping the OCNGS facility or an alternate site on threatened and endangered species under NMFS jurisdiction.

CONCLUSION

After reviewing the best available information on the status of endangered and threatened species under NMFS jurisdiction, the environmental baseline for the action area, the effects of the proposed action, interdependent and interrelated actions and the cumulative effects, it is NMFS' biological opinion that the proposed action may adversely affect but is not likely to jeopardize the continued existence of the loggerhead, Kemp's ridley or green sea turtles. No critical habitat is designated in the action area; therefore, none will be affected by the proposed action.

In the Incidental Take Statement accompanying this BO (see page 48), NMFS has determined that removal of sea turtles from the water and transfer of these sea turtles to an appropriate STSSN facility (such as the MMSC) is necessary and appropriate to ensure that sea turtles are monitored, rehabilitated and treated as necessary and that they are released back into the wild at a suitable location. The effects of holding and transfer to the facility on listed species in the action area are outlined below.

Effects of holding and relocation to MMSC as required by the Incidental Take Statement
NMFS has estimated that up to 8 sea turtles are likely to be captured at the OCNGS annually. While removal from the water, taking measurements, holding the sea turtles and transferring the turtles to a rehabilitation facility will cause stress and temporarily disrupt normal foraging and migratory behaviors, once released into the wild these turtles are likely to rapidly resume normal behaviors. Sea turtles are typically transferred to MMSC within a couple of hours of capture. Only 1 sea turtle (a Kemp's ridley) has died at MMSC after transfer from OCNGS and a necropsy indicated that the sea turtle died from injuries and infection sustained prior to impingement at the intakes. NMFS has no information to suggest that the handling and transfer of sea turtles to a facility such as MMSC will have any significant adverse effects on sea turtles. Removal of sea turtles from the water at the OCNGS intakes will ensure that these turtles are not subject to additional injury or eventual death at the intakes and that they will be released into the wild at a suitable location. Additionally, the transfer of sea turtles to an appropriate facility ensures that any sea turtles needing medical attention can be properly cared for. Two sea turtles removed from OCNGS have been eventually sent to a rehabilitation center in Topsail, North Carolina for surgery to repair injuries either sustained at OCNGS or prior to impingement. As such, NMFS believes that the removal of sea turtles from the water at OCGNS and the transfer of these turtles to an appropriate stranding facility will have a net beneficial effect to these turtles.

Synthesis of effects of transfer to rehabilitation facility and other required monitoring activities
NMFS has estimated that 8 sea turtles are likely to be impinged or captured at the OCNGS intakes each year. Of these sea turtles, up to 3 may already be dead when they are removed from the water; however, in some years all of the sea turtles captured or impinged have been alive. NMFS anticipates that up to 8 sea turtles a year will be removed from the water, measured, weighed, held and transferred to an appropriate STSSN facility, such as the MMSC. While the measuring of sea turtles will cause additional handling of these individuals and may cause stress, this is likely to be temporary and there are no known lasting effects of taking these measurements. The holding of sea turtles and transport to a stranding facility will temporarily disrupt normal foraging and migratory behaviors; however, once returned to the wild these turtles are likely to rapidly resume normal behaviors. As such, the holding, measuring, handling and transfer of live sea turtles is not likely to have a significant adverse effect on these sea turtles. The handling, measuring and transfer of dead sea turtles will not have any additional effects on these turtles as they are already dead.

Kemp's ridley sea turtles
As noted above, NMFS has determined that the capture or impingement of up to 8 Kemp's ridley sea turtles annually over the course of the 20 year license, including the death of up to 3 of these turtles each year, is not likely to jeopardize the continued existence of this species. No additional deaths are likely to be attributable to measuring, handling or transfer. As explained above, the measuring, handling and transfer is not likely to cause any long lasting or significant adverse effects to these turtles and is likely to have a net beneficial effect.

Loggerhead sea turtles
As noted above, NMFS has determined that the capture or impingement of up to 3 loggerhead sea turtles annually over the course of the 20 year license, including the death of 1 of these turtles

each year, is not likely to jeopardize the continued existence of this species. No additional deaths are likely to be attributable to measuring, handling or transfer. As explained above, the measuring, handling and transfer is not likely to cause any long lasting or significant adverse effects to these turtles and is likely to have a net beneficial effect.

Green sea turtles

As noted above, NMFS has determined that the capture, impingement or death of 1 green sea turtle annually over the course of the 20 year license is not likely to jeopardize the continued existence of this species. No additional deaths are likely to be attributable to measuring, handling or transfer. As explained above, the measuring, handling and transfer is not likely to cause any long lasting or significant adverse effects to these turtles and is likely to have a net beneficial effect.

Conclusion of effects of holding and relocation

After reviewing the best available information on the status of endangered and threatened species under NMFS jurisdiction, the environmental baseline for the action area, the effects of the action, and the cumulative effects, it is NMFS' biological opinion that the monitoring, holding and relocation of sea turtles required by the Incidental Take Statement will have the beneficial effect of ensuring that these sea turtles are properly cared for and released back into the wild at a suitable location. Adding these procedures to the overall project is not likely to jeopardize the continued existence of the Kemp's ridley, loggerhead, or green sea turtles. Because no critical habitat is designated in the action area, none will be affected. NMFS has determined that the proposed action of renewing the operating license for the OCGNS and the measuring, holding and transfer of sea turtles as required by the Incidental Take Statement and the two actions together are not likely to jeopardize the continued existence of any threatened or endangered species. Overall, holding and relocation to an appropriate facility will be a net benefit to the sea turtles.

INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by NMFS to include any act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns including breeding, spawning, rearing, migrating, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by NRC so that they become binding conditions for the exemption in section 7(o)(2) to apply. NRC has a continuing duty to regulate the activity covered by this Incidental Take Statement. If NRC (1) fails to assume and implement the terms and conditions or (2) fails to adhere to the terms and conditions of the Incidental Take Statement through enforceable terms, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, NRC must report the progress of the action and its impact on the species to the NMFS as specified in the Incidental Take Statement [50 CFR §402.14(i)(3)].

Amount or Extent of Take

The renewal of the operating license for the OCNGS will authorize the facility to continue operating for an additional 20 years. This action has the potential to directly affect Kemp's ridley, loggerhead and green sea turtles due to impingement at the CWS and DWS intakes. These interactions are likely to cause injury and/or mortality to the affected sea turtles. In addition, the removal of sea turtles from the water and transfer to a rehabilitation facility may cause stress and will disrupt the sea turtles normal foraging and migratory behaviors. Based on the distribution of sea turtles in the action area and information available on historic interactions between sea turtles and the OCNGS, NMFS anticipates that no more than 8 sea turtles are likely to be captured or impinged at the facility each year. NMFS anticipates that of these 8 sea turtles, no more than 3 of these turtles are likely to be loggerheads and no more than 1 of these sea turtles are likely to be a green. NMFS anticipates that up to 3 of these 8 sea turtles captured or impinged may be dead; of the dead sea turtles, no more than 1 is likely to be a green sea turtle and no more than 1 is likely to be a loggerhead. All of the sea turtles captured or impinged are likely to be injured due to interactions with the trash bars.

While the handling of decomposed turtles or turtle parts is considered to be a take, NMFS is most concerned with the takes that appear to be fresh dead sea turtles and therefore directly attributable to the operation of the OCNGS. NMFS recognizes that previously dead sea turtles may become impinged on the intakes at OCNGS and that some number of dead sea turtles taken at the facility may not necessarily be related to the operation of the facility itself. Due to the difficulty in determining the cause of death of sea turtles found dead at the intakes and the

inconsistency in the ability of NRC and the applicant to secure prompt necropsy results, the aforementioned anticipated level of take includes sea turtles that may have been dead prior to impingement on the OCNGS intakes.

NMFS believes this level of incidental take is reasonable given the seasonal distribution and abundance of these species in the action area, the level of take historically during dredging operations at projects nearby the action area, and the level of take of sea turtles during other relocation trawling operations. In the accompanying BO, NMFS determined that this level of anticipated take is not likely to result in jeopardy to the species.

In order to effectively monitor the effects of this action, it is necessary to examine the sea turtles that are captured at the facility. Monitoring provides information on the characteristics of the sea turtles encountered and may provide data which will help develop more effective measures to avoid future interactions with listed species. Additionally, as release of sea turtles back into the water at OCNGS is inappropriate as it would subject the sea turtles to additional stress and increase the likelihood of injury or mortality at the intakes, it is necessary to transfer the sea turtles to an appropriate STSSN facility. Currently, AmerGen has an agreement with the MMSC where upon capturing a sea turtle at the facility, AmerGen staff notifies MMSC and the turtle is transferred to MMSC care. NMFS believes that this procedure is necessary to effectively monitor the effects of the action and to ensure that the sea turtles are released back into the wild at an appropriate location. MMSC is authorized to care for, rehabilitate and release sea turtles pursuant to a Stranding Network Agreement and a permit issued by the USFWS pursuant to Section 10 of the ESA. As outlined below, NMFS is requiring NRC to ensure that AmerGen continue this arrangement with MMSC or another appropriate STSSN approved and permitted facility. However, as the handling and transport of sea turtles may affect individuals by subjecting them to extended holding times and stress, the effects of this action have been considered in the accompanying Opinion. In the Opinion, NMFS has determined that no more than 8 sea turtles annually (i.e., the total number likely to be captured during this action) are likely to be directly affected by measuring, holding and transport. Reasonable and prudent measures and implementing terms and conditions requiring this monitoring and transport are outlined below.

Reasonable and Prudent Measures

NMFS believes the following reasonable and prudent measures are necessary and appropriate to minimize impacts of incidental take of endangered and threatened sea turtles:

1. OCNGS must implement a NMFS approved program to prevent, monitor, minimize, and mitigate the incidental take of sea turtles at the CWS and DWS intake structures.

2. All sea turtle impingements associated with the OCNGS and sea turtle sightings in the action area must be reported to NMFS.

3. All live sea turtles must be transported to an appropriate facility for necessary rehabilitation and release into the wild.

4. A necropsy of any dead sea turtles must be undertaken promptly to attempt to identify the cause of death, particularly whether the sea turtle died as a result of interactions with the intakes.

Terms and Conditions

In order to be exempt from prohibitions of section 9 of the ESA, NRC must comply with and ensure OCNGS complies with, the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

1. To implement RPM #1, the CWS and DWS (when operational) intake trash bars must be cleaned daily from June 1 to October 31.

    a. Cleaning must include the full length of the trash rack, i.e., down to the bottom of each intake bay. To lessen the possibility of injury to a turtle, the raking process must be closely monitored so that it can be stopped immediately if a turtle is sighted.

    b. Personnel must be instructed to look beneath surface debris before the rake is used to lessen the possibility of injury to a turtle.

    c. Personnel cleaning the racks must inspect all trash that is dumped to ensure that no sea turtles are present within the debris.

    d. An alternative method of daily cleaning of the full length of the trash racks must be developed for use between June 1 through October 31 when the trash rake is unavailable due to necessary repair or maintenance or is otherwise inoperable. If the trash rake will be inoperable for more than 24 hours, AmerGen or NRC must contact NMFS and explain what alternate arrangements have been made to ensure that the full length of the trash racks is cleaned at least once per 24 hours.

2. To implement RPM #1, inspection of CWS and DWS cooling water intake trash bars (and immediate area upstream) must continue to be conducted at least once every 4 hours (three times per 12-hour shift) from June 1 through October 31. NRC must ensure that inspections follow a set schedule so that they are regularly spaced rather than clumped. Inspections must occur at least three times during each 12 hour shift. A proposed schedule would be to schedule inspections 2 hours after the start of each shift and then every 4 hours during the shift. Times of inspections, including those when no turtles were sighted, must be recorded.

3. To implement RPM #1, lighting must be maintained at the intake bays to enable inspection personnel to see the surface of each intake bay and to facilitate safe handling of turtles which are discovered at night. Portable spotlights must be available at both the CWS and the DWS for times when extra lighting is needed.

4. To implement RPM #1, dip nets, baskets, and other equipment must be available at both the CWS and the DWS and must be used to remove smaller sea turtles from the OCNGS intake structures to reduce trauma caused by the existing cleaning mechanism. Equipment suitable for rescuing large turtles (e.g., rescue sling or other provision) must be available at OCNGS and readily accessible from the CWS and DWS.

5. To implement RPM #1, an attempt to resuscitate comatose sea turtles must be made according to the procedures described in Appendix II. These procedures must be posted in appropriate areas such as the intake bay areas for both the CWS and the DWS, any other area where turtles would be moved for resuscitation, and the CWS and DWS operator's office(s).

6. To implement RPM #1, OCNGS personnel must observe the canal area for sea turtles where and when possible (i.e., during the daylight hours). Any sea turtles sighted in the canal and in vicinity of OCNGS (not necessarily only near the intake structures) must be reported to NMFS within 24 hours of the observation (Pat Scida, Endangered Species Coordinator at (978) 281-9208 or FAX (978) 281-9394).

7. To implement RPM #2, if any live or dead sea turtles are taken at OCNGS, plant personnel must notify NMFS within 24 hours of the take (NMFS Endangered Species Coordinator at 978-281-9208). An incident report for sea turtle take (Appendix III) must also be completed by plant personnel and sent to the Endangered Species Coordinator via FAX (978-281-9394) within 24 hours of the take. Every sea turtle must be photographed. Information in Appendix IV will assist in identification of species impinged. All sea turtles that are sighted within the vicinity of OCNGS (including the intake and discharge structures) must also be recorded, and this information must be submitted in the annual report.

8. To implement RPM #2, an annual report of incidental takes must be submitted to NMFS by January 1 of each year. This report will be used to identify trends and further conservation measures necessary to minimize incidental takes of sea turtles. The report must include, as detailed above, all necropsy reports, incidental take reports, photographs (if not previously submitted), a record of all sightings in the vicinity of OCNGS, and a record of when inspections of the intake trash bars were conducted for the 24 hours prior to the take. The annual report must also include any potential measures to reduce sea turtle impingement or mortality at the intake structures. This annual report must also include information on arrangements made with a STSSN facility to handle sea turtles taken in the coming year. The report must also include all necropsy reports. At the time the report is submitted, NMFS will supply NRC and AmerGen with any information on changes to reporting requirements (i.e., staff changes, phone or fax numbers, e-mail addresses) for the coming year.

9. To implement RPM #2, OCNGS personnel or NRC must notify NMFS when the OCNGS reaches 50% of the incidental take level for any species of sea turtle. At that time, NRC

and NMFS will determine if additional measures are needed to minimize impingement at the CWS or DWS intake structures.

10. To implement RPM #3, a stranding/rehabilitation facility with the appropriate ESA authority must be contacted immediately following any live sea turtle take. Appropriate transport methods must be employed following the stranding facilities protocols, to transport the animal to the care of the stranding/rehabilitation personnel for evaluation, necessary veterinary care, tagging, and release in an appropriate location and habitat.

11. To implement RPM #4, all dead sea turtles must be necropsied by qualified personnel. The OCNGS must coordinate with a qualified facility or individual to perform the necropsies on sea turtles impinged at OCNGS, prior to the incidental turtle take, so that there is no delay in performing the necropsy or obtaining the results. The necropsy results must identify, when possible, the sex of the turtle, stomach contents, and the estimated cause of death. Necropsy reports must be submitted to the NMFS Northeast Region with the annual review of incident reports or, if not yet available, within 60 days of the incidental take.

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the potential for and impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, the level of incidental take is exceeded, reinitiation of consultation and review of the reasonable and prudent measures are required. NRC must immediately provide an explanation of the causes of the taking and review with NMFS the need for possible modification of the reasonable and prudent measures.

CONSERVATION RECOMMENDATIONS

In addition to Section 7(a)(2), which requires agencies to ensure that all projects will not jeopardize the continued existence of listed species, Section 7(a)(1) of the ESA places a responsibility on all federal agencies to "utilize their authorities in furtherance of the purposes of this Act by carrying out programs for the conservation of endangered species." Conservation Recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. As such, NMFS recommends that the NRC consider the following Conservation Recommendations:

1. The NRC and OCNGS should investigate methods to increase lighting and visibility at all trash racks, and implement these methods. At present, with use of portable spotlights and current lighting visibility is limited to approximately 1 meter below the water surface. Improvement of visibility may allow personnel to detect sea turtles at the intakes sooner and minimize the chance of mortality.
2. The NRC and OCNGS should support tissue analysis of dead sea turtles removed from OCNGS to determine contaminant loads, including chlorine.

2. In conjunction with NMFS, the NRC should support and develop a research program to determine whether the plant provides features attractive to sea turtles (e.g., concentration of prey around intake structures, heated discharge). This program should investigate habitat use, diet, and local and long-term movements of sea turtles. Use of existing mark/recapture and telemetry methods should be considered in Barnegat Bay and associated waterways.

3. The NRC and OCNGS personnel should support and conduct underwater and surface videography or diving behavior telemetry studies of turtles at the intake bays, in the Forked River, in the Oyster Creek discharge canal, and in Barnegat Bay to determine how turtles use these waterways and their behavior in the intake bays. The surface videography could help identify sea turtles in Forked River prior to impingent in the intake structures.

4. The NRC and OCNGS personnel should support and conduct investigations on the variable environmental conditions which may contribute to or result in increased sea turtle taking (e.g. temperature changes, wind direction, influx of prey). Increased monitoring during favorable conditions for sea turtle presence near OCNGS should result from the investigations.

5. Historical benthic survey data should be reviewed and updated to identify sea turtles prey density and distribution at various sites in the action area and associated waterways. This information would clarify the potential for sea turtle prey to be attracted to the intake structures or area around OCNGS during times when turtles are likely to be in the action area.

6. The NRC and OCNGS personnel should support and conduct in-water assessments, abundance, and distribution surveys for sea turtles in Barnegat Bay, Forked River, and Oyster Creek. Information obtained from these surveys should include the number of turtles sighted, species, location, habitat use, time of year, and portions of the water column sampled.

REINITIATION OF CONSULTATION

This concludes formal consultation on the proposal by NRC to renew the Operating License for the Oyster Creek Nuclear Generating Station for an additional 20 years. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of taking specified in the incidental take statement is exceeded; (2) new information reveals effects of the action that may not have been previously considered; (3) the identified action is subsequently modified in a manner that causes an effect to listed species; or (4) a new species is listed or critical habitat designated that may be affected by the identified action. In instances where the amount or extent of incidental take is *exceeded*, Section 7 consultation must be reinitiated immediately.

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APPENDIX I.

Incidental Take of Sea Turtles at Oyster Creek Nuclear Generating Station Intake Structures

January 1992 through October 2006

SEA TURTLE IMPINGEMENT							
Date/Time	*Species*	*Status*	*Length**	Weight	*Location*	*Temp*	*Details*
6/25/1992 1250 hrs	Cc	Dead	35.5 cm SCL	9.6 kg	Impinged on DWS trash bars, found upon routine inspection	21.6 C	Several deep gashes on side, appeared to be boat propeller wounds. MMSC necropsy concluded cause of death from propeller wounds, before impingement.
9/9/1992 1800 hrs	Cc	Alive	46.7 cm SCL	19.1 kg	Impinged on CWS trash bars, found upon routine inspection	25.6 C	Small wound with scar tissue behind head. Released into discharge canal.
9/11/1992 1400 hrs	Cc	Alive	46.7 cm SCL	19.1 kg	Impinged on CWS trash bars, found upon routine inspection	26.2 C	Small wound with scar tissue behind head. Considered to be the same turtle found on 9/9/92. Taken to MMSC, tagged, and released into ocean near Brigantine, NJ.
10/26/1992 0300 hrs	Lk	Alive	32.0 cm SCL	5.7 kg	Impinged on CWS trash bars, found upon routine inspection. Head out of water pointing upward.	11.3 C	Turtle found alive, moving about normally. Two scars from slash-like wounds on plastron. Not sure how long present at intake structure, but may have been there between 3 and 8 hours. Turtle taken to MMSC in Brigantine, NJ, then to North Carolina, with eventual release into the ocean off NC on October 31, 1992.
10/17/1993 1200 hrs	Lk	Dead	26.0 cm SCL	3.0 kg	Impinged on DWS trash bars, found upon routine inspection	16.7 C	Turtle found limp, immobile, no apparent breathing and resuscitation efforts were unsuccessful. Minor scrape marks on plastron may have occurred during removal from intake area. Not sure how long present at intake structure, but may have been there between 4 and 8 hours. Necropsy by Dr. Morreale found that drowning likely cause of death (fresh dead, no obvious trauma, empty stomach).
6/19/1994 1330 hrs	Cc	Alive	36.8 cm SCL	9.8 kg	Found in CWS Bay #4, swimming freely upstream of the trash bars	27.3 C	Turtle found alive, moving about normally. Within 3-4 hours of capture, turtle taken to MMSC in Brigantine, NJ, tagged, and released offshore.
7/1/1994 1000 hrs	Lk	Dead	27.7 cm SCL	3.6 kg	Found in DWS Bay #5 upon routine cleaning	25.7 C	Turtle found limp, immobile, no apparent breathing, strong odor of decomposition, and resuscitation efforts were unsuccessful. Not sure how long present at intake structure, but intake bay was cleaned the previous afternoon. Turtle sent to Cornell for necropsy but the results have not been received to date.

7/6/1994 0640 hrs	Cc	Dead	61.4 cm SCL	40.4 kg	Found in DWS Bay #4 upon routine cleaning of dilution intakes	26.9 C	Turtle found limp, immobile, no apparent breathing and resuscitation efforts were unsuccessful. Three old deep scars or slash-like propeller wounds on turtle, decomposition of all 4 appendages, large notch along turtle's marginal scutes. Not sure how long present at intake structure, but trash bars were cleaned 6 to 8 hours earlier. Necropsy by MMSC (R. Schoelkopf) found that turtle likely died 1 to 2 days before arriving at OCNGS, probably due to a long term illness.
7/12/1994 2240 hrs	Lk	Dead	26.7 cm SCL	3.3 kg	Found in DWS Bay #4 upon routine cleaning of dilution intakes	28.4 C	Turtle found limp, immobile, no apparent breathing and resuscitation efforts were unsuccessful. Not sure how long present at intake structure, but may have been there for several hours. Turtle sent to Cornell for necropsy but the results have not been received to date.
9/4/1997 0318 hrs	Lk	Dead	48.8 cm SCL	18.1 kg	Found in DWS Bay #6 upon routine cleaning of dilution intakes	22.9 C	Turtle found limp, immobile, no apparent breathing and resuscitation efforts were unsuccessful. Two dorsal scutes had damage, but no prominent scars of slashlike wounds. Not sure how long present at intake structure, but may have been there for up to several hours.
8/18/1998 0959 hrs	Cc	Alive	50.8 cm SCL	22.4 kg	Found live while routinely inspecting CWS Bay #4, swimming freely upstream of the trash bars	26.9 C	Turtle found alive, moving about normally. A 12 foot 1/4" polypropylene rope with a bucket attached to one end was wrapped around the right front flipper, and the flipper was atrophied and partially decayed. OCNGS was in full power operation with four circulating water pumps and 2 dilution pumps. Turtle taken to MMSC in Brigantine, NJ, then to Sea World in Orlando, FL, with eventual release into the ocean.
9/23/1999 0310 hrs	Lk	Alive	26.4 cm SCL	2.9 kg	Impinged on CWS trash bars, found upon routine inspection	19.6 C	Turtle found alive, moving about normally and with no apparent injury. OCNGS was in full power operation with four circulating water pumps and 2 dilution pumps. Turtle taken to MMSC in Brigantine, NJ, then to Virginia State Aquarium, with eventual release into the ocean.
10/23/1999 0200 hrs	Cm	Dead	27.0 cm SCL	2.8 kg	Found in DWS Bay #4 upon routine cleaning of dilution intakes	17.1 C	Turtle found limp, immobile, no apparent breathing and resuscitation efforts were unsuccessful. OCNGS was in full power operation with four circulating water pumps and 2 dilution pumps. Dilution trash racks were mechanically cleaned the previous day. Turtle sent to Cornell for necropsy, but results have not been received to date.
06/23/2000 0120 hrs	Cc	Alive	47.8cm SCL	17.2 kg	Found in front of trash bars in DWS Bay #1 intake	25.3 C	Live turtle very active and no visible wounds or injury. OCNGS was in full power operation with four circulating water pumps and 2 dilution pumps. Transferred to MMSC in Brigantine NJ, with eventual release into the ocean.

7/2/2000 1500 hrs	Lk	Dead	27.3 cm SCL	3.2 kg	Found floating into the trash bars in DWS Bay #1 intake on routine inspection of dilution trash racks	25.6 C	Turtle found limp, immobile, no apparent breathing and resuscitation efforts were unsuccessful. Two dorsal scutes had superficial scrape marks. OCNGS was in full power operation with four circulating water pumps and 2 dilution pumps. Dilution trash racks were mechanically cleaned the previous evening (2130 hrs). Turtle in freezer until necropsy can be completed.
8/3/2000 1525 hrs	Cm	Alive	29.2 cm SCL	3.4 kg	Found live in DWS Bay #4 intake upon routine inspection of dilution trash racks	28.8 C	Turtle found alive, moving about normally and with no apparent injury. Carapace covered in barnacles; several marginal scutes had dull grayish coloration (indicative of possible fungal infection). OCNGS was in full power operation with four circulating water pumps and 2 dilution pumps. Dilution trash racks mechanically cleaned earlier the same day. Turtle taken to MMSC in Brigantine, NJ, then to the Topsail Island Rehab Center, NC, with eventual release into the ocean on October 12, 2000.
8/28/2000 0112 hrs	Lk	Alive	26.2 cm SCL	2.9 kg	Found live in DWS Bay #1 intake upon routine inspection of dilution trash racks	26.5 C	Turtle found alive, moving about normally and with no apparent injury. OCNGS was in 72% power operation with four circulating water pumps and 2 dilution pumps. Dilution trash racks cleaned previous day and inspected earlier same night of capture. Turtle taken to MMSC in Brigantine, NJ, then to the Topsail Island Rehab Center, NC, with anticipated eventual release into the ocean.
9/18/2000 1310 hrs	Cc	Alive	57.2 cm SCL	26.5 kg	Found live while routinely inspecting CWS intake trash rack Bay #4	20.4 C	Turtle found alive, moving normally with no apparent injury. Majority of dorsal surface covered in barnacles; few scutes partially peeled. OCNGS was in full power operation with four circulating water pumps and 2 dilution pumps. Trash racks cleaned previous afternoon. Turtle taken to MMSC in Brigantine, NJ, and released into the ocean off Nags Head, NC in late September.
7/8/2001 1430 hrs	Cm (juv)	Alive	26.7 cm SCL	2.3 kg	Found live while routinely inspecting CWS Bay #4	26.7 C	Turtle found alive, swimming freely in Bay #4, moving normally with no apparent injury. Dorsal surface had several barnacles. OCNGS was in full power operations with four circulating water pumps and 2 dilution pumps. Trash racks cleaned the previous afternoon. Turtle taken to Marine Mammal Stranding Center in Brigantine, NJ. After confirming health and tagged, turtle released into nearshore waters near Brigantine.
7/22/2001 1744 hrs	Lk (juv)	Dead	26 cm SCL	2.9 kg	Impinged on DWS Bay #5 trash bars, found upon routine inspection	26.9 C	Turtle found with deep slice wound between head and carapace on left side of neck. OCNGS was in full power operation with four circulating water pumps and 2 dilution pumps. Trash racks cleaned at 330 hrs same day. Turtle in freezer until necropsy could be set up.

8/14/2001 0334 hrs	Lk	Dead	22.8 cm SCL; 21.4 cm SCW		Impinged on DWS Bay #6	27.8 C	Turtle appears fresh dead, no obvious prop wounds. Several scutes scraped on carapace centerline and posterior notch. Intake velocity was 73 cm/sec and OCNGS had 982 percent power generating capacity over previous 48 hrs. Trash racks cleaned at 245 hrs same day. Intake canal turbidity high.
6/29/2002 0200	Lk	Alive	25.4 cm SCL; 24.1 cm SCW	n/a	Found alive, swimming in CWS Bay #5 and #6 cooling water intake, upon routine inspection of trash racks. Removed with large dipnet.	26.2 C	Turtle alive and active, appears healthy. Fresh scar (?) on right side of carapace. OCNGS had 99.9% power. CWS trash racks cleaned ~4 hrs earlier (2200 6/28/02). Animal delivered to MMSC at 0455 hrs - wound determined to not be of significant concern (eating and appeared healthy). Turtle later died at MMSC, and necropsy performed. Found to be female, all tissues surrounding cracked area were necrotic.
7/3/2002 0755	Lk	Alive	34 cm SCL; 32.5 cm SCW	6 kg	Found alive, swimming in front of DWS Bay #5 intake trash bars, upon routine inspection. Removed with dipnet.	28.2 C	Turtle alive and active, appears healthy. One small scrape <1 cm long on dorsal scute. OCNGS had 100% power. Screen last inspected 7-3-02 0500 hrs. Animal delivered to MMSC at 1015 hrs; was swimming and eating well. Tagged (monellear #SSL127) and released on July 9 near Brigantine, NJ.
9/24/2003 1455	Lk	Alive	31.1 cm SCL; 30.5 cm SCW	11.5 lbs	Found alive, in intake pipe at DWS Bay #6.	73 F	Turtle alive and active, appears healthy. One lateral scute chipped (old); 2 scrapes on ventral surface. OCNGS had 100% power. Screen last inspected 9-23-03 1345 hrs. Animal picked up by MMSC at 1745 hrs; healthy and active. Tagged and released on 9-25 near Brigantine, NJ.
10/24/2003 0850	Cm (juv)	Alive	36.2 cm SCL; 30.5 cm SCW	6.9 kg	Found alive, against CWS Intake Bay #4.	53 F (11.7 C)	Turtle alive and alert, appears healthy but a bit lethargic. One scraped dorsal scute and one chipped lateral scute. Heavy algal growth on carapace. OCNGS had 98% power. Screen last inspected 10-24-03 0500 hrs. Animal picked up by MMSC at 1030 hrs; healthy and active. Held at MMSC and then transferred to VMSM for rehab and eventual release.
7/4/2004 1215 hrs	Lk	Dead	26.5 cm SCL; 25 cm SCW	5.4 kg	Found dead upon routine cleaning at DWS Bay #4 trash racks	25.6 C (78 F)	Turtle fresh dead, no obvious prop wounds or other injuries. Minor scrape/bruising on plastron near centerline. OCNGS had 100% percent power generating capacity over previous 48 hrs. Trash racks cleaned at 0800 hrs same day. Delivered to MMSC for necropsy at 1500 hrs: female; all internal organs healthy/unremarkable; stomach of crab parts; lungs appeared normal but sank in salt water solution and felt compressed. Probable cause of death--suffocation.
7/11/2004 1422 hrs	Lk	Alive	23 cm SCL; 22 cm SCW	1.8 kg	Upon routine cleaning, found swimming upstream of DWS Bay #5 trash racks. Turtle surfaced and dove, and personnel retrieved the animal	81.5 F (27.5 C)	Turtle appeared in good condition. Some minor scrapes noted on ventral surface of carapace (plastron?). OCNGS had 100% power. Screen last inspected 7-11-04 at 1315 hrs. Animal taken to MMSC at 1623 hrs. Examined and released 2 days later off Brigantine, NJ.

7/16/2004 1100 hrs	Lk	Alive	28 cm SCL	3.1 kg	Found alive upon routine cleaning of DWS Bay #5 trash racks	76 F (22.4 C)	Turtle appeared in good condition. Some small scrapes noted on plastron. OCNGS had 100% power. Screen last inspected 7-16-04 at 0900 hrs. Animal taken to MMSC at 1300 hrs. Examined and released off Brigantine, NJ.
7/20/2004 1213 hrs	Lk	Dead	18.3 cm SCL	0.8 kg	Found dead upon routine cleaning of CWS Bay #1 trash racks	79.7 F (26.5 C)	Resuscitation attempted but unsuccessful. Small puncture wound 1.3 cm diameter in left rear surface of carapace. OCNGS had 100% power. Screen last inspected 7-19-04 at 2115 hrs. Taken to MMSC at 1000 on 7-21-04 for necropsy.
8/7/2004 0900 hrs	Lk	Alive	27 cm SCL	3.2 kg	Found alive upon routine cleaning of DWS Bay #5 trash racks	72.8 F (22.7 C)	Turtle appeared healthy and moving normally. Small bruise noted on plastron and healed scar from previous injury on left side of head in front of eye. OCNGS had 100% power. Screen last inspected 8-7-04 at 0515 hrs. Animal taken to MMSC on 8-7-04. Examined and subsequently released into ocean off Brigantine, NJ. **EXCEEDED ITS**
9/11/2004 1010 hrs	Lk	Dead	22.3 cm SCL; 22.9 cm SCW	2.2 kg	Found dead upon routine cleaning of DWS Bay #5 trash racks	24.3 C	Bruising to plastron and undersides of all 4 flippers. Small puncture wound to base of neck. Healed prop cut to rear of carapace. Animal taken to MMSC, then to U of Penn for necropsy. **EXCEEDED ITS**
9/12/2004 2329 hrs	Lk	Alive	21 cm SCL; 19.5 cm CW	1.4 kg	Found alive upon routine cleaning of CWS #5 trash racks	24.9 C	Active and eating on its own. Bruising to plastron and undersides of all 4 flippers. Missing left front flipper (clean amputation). Small bump on beak area of head. Turtle was taken to the MMSC in Brigantine, NJ, where it was examined, measured, fed and held for observation prior to release. The turtle was transported to the VMSM for tagging and release. **EXCEEDED ITS**
9/23/2004 2145 hrs	Lk	Alive	24.2 cm SCL	1.9 kg	Found alive swimming in CWS Bay #3 cooling water intake, upon routine inspection of trash racks.	21.9 C	Turtle appeared alert and responsive. Turtle was taken to the MMSC in Brigantine, NJ, where it was examined, measured, fed and held for observation prior to release. The turtle was transported to the VMSM for tagging and release. **EXCEEDED ITS**
7/4/2005 0905 hrs	Lk	Dead	23.2 cm SCL	1.4 kg	Found in DWS Bay #1 upon routine cleaning of dilution intakes	21.9 C	Turtle was found dead among . Turtle was taken to the MMSC in Brigantine, NJ, where it was examined, measured, the necropsy was preformed.- necropsy results: skill crushed by possible prop strike, right carapace near shoulder cracked possible prop or skeg wound. unable to determine if injuries were pre or post mortem. esophagus lined with black, gritty material. stomach and intestine empty. immature male
8/5/2005 0500 hrs	Lk	Alive	23.6 cm SCL	1.9 kg	Found alive swimming in CWS Bay #4 cooling water intake, upon routine inspection of trash racks.	28.2 C	Turtle appeared alert and responsive, wound observed on front left flipper. Turtle was taken to the MMSC in Brigantine, NJ, where it was examined, measured, fed and held for observation. The turtle was then sent to the Sea Turtle Rescue and Rehabilitiation Center in Topsail, NC for further rehab. On August 12, the turtle was trasported to the NC State Veterinary School for amputation of the wounded flipper. The turtle will undergo further rehab before being released.

35

6/30/2006 1100 hrs	LK	Alive	27.3cm SCL, 25.8 cm SCW	3.5kg	Found among the vegetation and debris removed from Bay #1 of the DWS	25.6C	Active, scrapes on dorsal and ventral carapace. Transferred to MMSC and released on July 5.
7/17/2006 0935 hrs	LK	Alive	25.2 SCL, 24.00 SCW	2.63 kg	In water within Bay #5 of the DWS	26.7C	lethargic during tranport but became alert and responsive at MMSC. minor abrasions on carapace, plastron and head. severe bruising on neck and base of all four flippers. Abrasions and bruising on neck and flippers. Transferred to MMSC. Appears to be doing fine. tagged and released by MMSC on July 19
7/19/2006 2130hrs	LK	Alive	26.7 SCL, 24.8 SCW	3.2kg	Found among the vegetation and debris removed from Bay #1 of the CWS	28.1C	Algae on carapce and minor bruising on plastron. It was found late at night and was transferred to MMSC on 7/20 am. Released by MMSC on July 23
7/25/2006 0425hrs	LK	Dead	28.5cm SCL, 26cm SCW	3.3kg	Found dead among the vegetation and debris removed from Bay #4 of the DWS	27.9C	Dead and moderately decomposed. OC staff reported that several scutes broken, areas of brusing and crushing wounds to carapace and plastron. Necropsy conducted by MMSC - stomach and intestines full of crab claws and parts. moderately decomposed. carapace and plastron show evidence of being crushed, possibly post-mortem. carapace had a rough break and scutes peeling off. buried by MMSC.
8/1/2006 0507hrs	CC	Alive	74 SCL, 65SWC	50.4kg	In water within Bay #1 of the CWS	29.4C	OC staff reported no visible wounds or bruising. numerous barnacles on carapace. transferred to MMSC - observed, doing well and released on August 2.
10/5/2006 0940hrs	CC	Alive	20.3 SCL		Found among the vegetation and debris removed from Bay #6 of the DWS	18.8C	dilution water intake bay 6 . Missing front right flipper but has scar tissue and is healed. Wound opened up from abrasion against trash rack. Transported to MMSC and then to Topsail for surgery to repair old wound.

APPENDIX II

Handling and Resuscitation Procedures Sea Turtles Found at OCNGS

Handling:
Do not assume that an inactive turtle is dead. The onset of rigor mortis and/or rotting flesh are often the only definite indications that a turtle is dead. Releasing a comatose turtle into any amount of water will drown it, and a turtle may recover once its lungs have had a chance to drain. There are three methods that may elicit a reflex response from an inactive animal:

- Nose reflex. Press the soft tissue around the nose which may cause a retraction of the head or neck region or an eye reflex response.
- Cloaca or tail reflex. Stimulate the tail with a light touch. This may cause a retraction or side movement of the tail.
- Eye reflex. Lightly touch the upper eyelid. This may cause an inward pulling of the eyes, flinching or blinking response.

General handling guidelines:
- Keep clear of the head.
- Adult male sea turtles of all species other than leatherbacks have claws on their foreflippers. Keep clear of slashing foreflippers.
- Pick up sea turtles by the front and back of the top shell (carapace). Do not pick up sea turtles by flippers, the head or the tail.
- If the sea turtle is actively moving, it should be retained at the OCNGS until transported by stranding/rehabilitation personnel to the nearest designated stranding/rehabilitation facility. The rehabilitation facility should eventually release the animal in the appropriate location and habitat for the species and size class of the turtle. Turtles should not be released where there is a risk of re-impingement at OCNGS.

Sea Turtle Resuscitation Regulations: (50 CFR 223.206(d)(1))
If a turtle appears to be comatose (unconscious), contact the designated stranding/rehabilitation personnel immediately. Once the rehabilitation personnel has been informed of the incident, attempts should be made to revive the turtle at once. Sea turtles have been known to revive up to 24 hours after resuscitation procedures have been followed.

- Place the animal on its bottom shell (plastron) so that the turtle is right side up and elevate the hindquarters at least 6 inches for a period of 4 up to 24 hours. The degree of elevation depends on the size of the turtle; greater elevations are required for larger turtles.
- Periodically, rock the turtle gently left to right and right to left by holding the outer edge of the shell (carapace) and lifting one side about 3 inches then alternate to the other side.
- Periodically, gently conduct one of the above reflex tests to see if there is a response.
- Keep the turtle in a safe, contained place, shaded, and moist (e.g., with a water-soaked towel over the eyes, carapace, and flippers) and observe it for up to 24 hours.
- If the turtle begins actively moving, retain the turtle until the appropriate rehabilitation personnel can evaluate the animal. The rehabilitation facility should eventually release the animal in a manner that minimizes the chances of re-impingement and potential harm to the animal (i.e., from cold stunning).
- Turtles that fail to move within several hours (up to 24) should be transported to a suitable facility for necropsy (if the condition of the sea turtle allows).

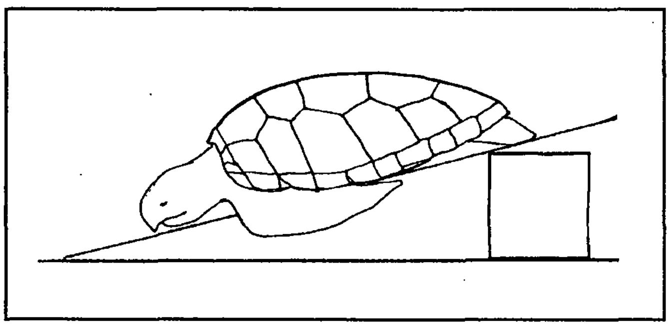
APPENDIX II, continued **(Handling and Resuscitation Procedures)**

Stranding/rehabilitation contact in New Jersey:
Bob Schoelkopf, Marine Mammal Stranding Center
P.O. Box 773
Brigantine, NJ
(609-266-0538)

Special Instructions for Cold-Stunned Turtles:

Comatose turtles found in the fall or winter (in waters less than 10□C) may be "cold-stunned". If a turtle appears to be cold-stunned, the following procedures should be conducted:

- Contact the designated stranding/rehabilitation personnel immediately and arrange for them to pick up the animal.
- Until the rehabilitation facility can respond, keep the turtle in a sheltered place, where the ambient temperature is cool and will not cause a rapid increase in core body temperature.



APPENDIX III

Incident Report of Sea Turtle Take - OCNGS

Photographs should be taken and the following information should be collected from all turtles (alive and dead) found in association with the OCNGS. Please submit all necropsy results (including sex and stomach contents) to NMFS upon receipt.

Observer's full name:____
Reporter's full name:____

Species Identification (Key attached):______________________________

Site of Impingement (CWS or DWS, Bay #, etc.):________________________

Date animal observed:______________ Time animal observed: ________________
Date animal collected:______________ Time animal collected:________________
Date rehab facility contacted: ______________ Time rehab facility contacted: ________
Date animal picked up: ________________ Time animal picked up: ____________

Environmental conditions at time of observation (i.e., tidal stage, weather):

____
____

Date and time of last inspection of screen:____________________________
Water temperature (□C) at site and time of observation:____________________
Number of pumps operating at time of observation:__________________________
Average percent of power generating capacity achieved per unit at time of observation:______
Average percent of power generating capacity achieved per unit over the 48 hours previous to observation:____

Sea Turtle Information: *(please designate cm/m or inches)*

Fate of animal (circle one): dead alive
Condition of animal (*include comments on injuries, whether the turtle is healthy or emaciated, general behavior while at OCNGS*):____________________________________
____
____
______________________________________*(please complete attached diagram)*

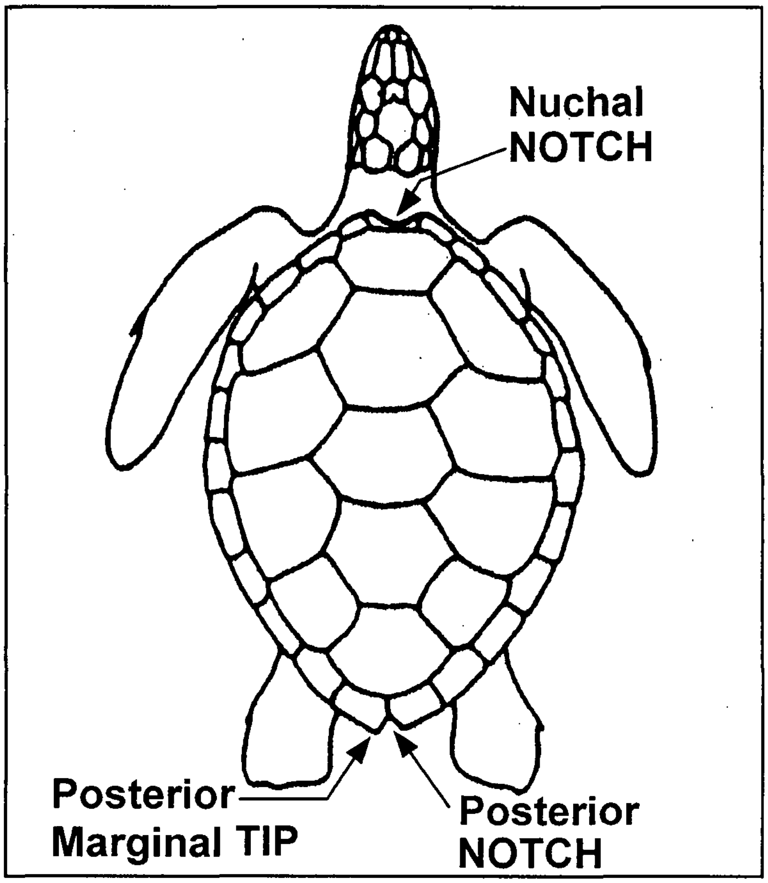
Carapace length - Curved:______________Straight:______________
Carapace width - Curved:______________Straight:______________

Existing tags?: YES / NO *Please record all tag numbers.* Tag # ________________
Photograph attached: YES / NO

(please label *species, date, location of impingement* on back of photograph)

APPENDIX III, continued **(Incident Report of Sea Turtle Take)**

Draw wounds, abnormalities, tag locations on diagram and briefly describe below.



Description of animal:

All information should be sent to the following address:

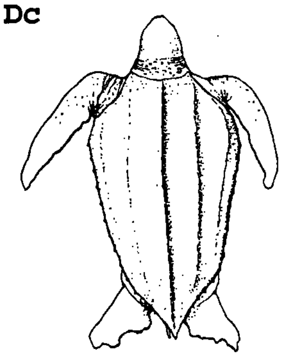
National Marine Fisheries Service, Northeast Region
Protected Resources Division
Attention: Endangered Species Coordinator
One Blackburn Drive
Gloucester, MA 01930
Phone: (978) 281-9328
FAX: (978) 281-9394

APPENDIX IV

Identification Key for Sea Turtles Found in Northeast U.S. Waters

SEA TURTLES

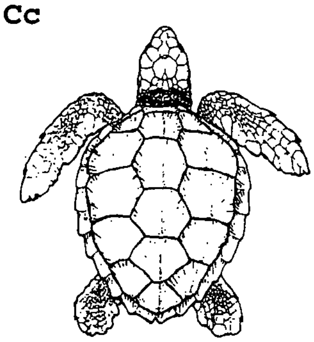
Dc



Leatherback (*Dermocheyls coriacea*)

Found in open water throughout the Northeast from spring through fall. Leathery shell with 5-7 ridges along the back. Largest sea turtle (4-6 feet). Dark green to black; may have white spots on flippers and underside.

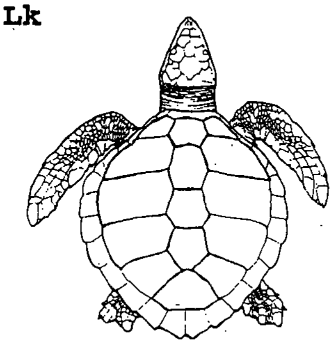
Cc



Loggerhead (*Caretta caretta*)

Bony shell, reddish-brown in color. Mid-sized sea turtle (2-4 feet). Commonly seen from Cape Cod to Hatteras from spring through fall, especially in southern portion of range. Head large in relation to body.

Lk



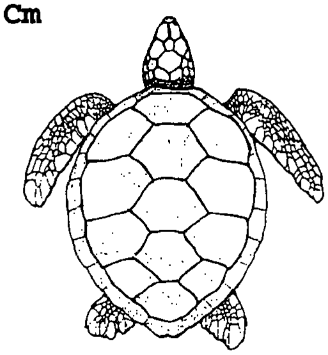
Kemp's ridley (*Lepidochelys kempi*)

Most often found in Bays and coastal waters from Cape Cod to Hatteras from summer through fall. Offshore occurrence undetermined. Bony shell, olive green to grey in color. Smallest sea turtle in Northeast (9-24 inches). Width equal to or greater than length.

APPENDIX IV, continued (**Identification Key**)

SEA TURTLES

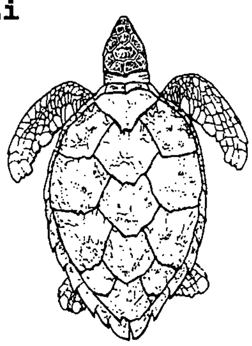
Cm



Green turtle (*Chelonia mydas*)

Uncommon in the Northeast. Occur in Bays and coastal waters from Cape Cod to Hatteras in summer. Bony shell, variably colored; usually dark brown with lighter stripes and spots. Small to mid-sized sea turtle (1-3 feet). Head small in comparison to body size.

Ei



Hawksbill (*Eretmochelys imbricata*)

Rarely seen in Northeast. Elongate bony shell with overlapping scales. Color variable, usually dark brown with yellow streaks and spots (tortoise-shell). Small to mid-sized sea turtle (1-3 feet). Head relatively small, neck long.

OCNGS Sea Turtle Impingement 1992

June 25, 1992

A dead sea turtle was removed from the intake grating on the dilution plant. It was identified by members of Oyster Creek Environmental Controls Department as a juvenile loggerhead sea turtle, Caretta caretta. Examination of this turtle revealed several deep gashes on its side which appeared to be boat propeller wounds (see Figures 1-3). The Marine Mammal Stranding Center (MMSC) of Brigantine, NJ was notified and requested to perform a necropsy. Robert Schoelkopf of MMSC subsequently confirmed our identification of the specimen as a juvenile loggerhead and indicated that it measured 35.5 cm (14 in.) carapace length (straight line measurement). The necropsy performed by MMSC confirmed that the cause of death was from boat propeller wounds and that the specimen was dead prior to becoming impinged at OCNGS.

September 9, 1992

During the evening of Wednesday, September 9, 1992 a live sea turtle was noticed impinged on the intake structure trash racks. The turtle was carefully removed by several plant personnel and released alive the same evening into the discharge canal. This specimen was tentatively identified by Environmental Controls personnel as a juvenile loggerhead. Although this individual was alive and healthy when released, it was noted that when captured it had a small wound surrounded by scar tissue just behind the head.

September 11, 1992

During a mid-afternoon tour of the intake structure, an OCNGS security officer noticed a live sea turtle at the intake structure trash racks. Other station personnel assisted in removing the turtle from the intake structure and keeping it watered down with seawater while Environmental Controls personnel notified the Marine Mammal Stranding Center. The turtle was identified by Environmental Controls personnel as a juvenile loggerhead sea turtle. It was noted to have a wound just behind the head similar to that noted on the loggerhead released at OCNGS on 9-9-92. It was taken from OCNGS in good condition at 1630 hours by an MMSC volunteer, who returned with it to the Stranding Center (Figure 4 & 5). It was assigned MMSC case number 92-91, and found to be a juvenile loggerhead 46.7 cm (18.4 in.) long and weighing 19.1 kg (42 lb.). The turtle was tagged with MMSC tags #NNK071 and #NNK072 and released in healthy condition near Brigantine (at 39°23'53" N. lat., 74°23'07" W. long.). MMSC personnel noted that this loggerhead had a small (1/4 in.) wound on the dorsal midline just behind the head. Robert Schoelkopf of MMSC stated that he believes it to be the same juvenile loggerhead which was collected and released at OCNGS on 9-9-92.

Figure 1
Juvenile loggerhead sea turtle collected at OCNGS on 6-25-92. Note severe boat propeller wounds.

Figure 2
Lateral view of loggerhead collected 6-25-92 showing severe gashes from boat propeller.

Figure 3
Closeup ventral view of loggerhead sea turtle collected dead on 6-25-92.

Figure 4
Live juvenile loggerhead sea turtle at OCNGS 9-11-92, prior to release near Marine Mammal Stranding Center, Brigantine, NJ.

Figure 5
Live juvenile loggerhead collected 9-11-92. Note small wound along dorsal midline just behind head.

NOV 2 5 1992

GPU Nuclear

GPU Nuclear Corporation
Post Office Box 388
Route 9 South
Forked River, New Jersey 08731-0388
609 971-4000
Writer's Direct Dial Number:

C330-92-2325
November 19, 1992

Mr. Michael Masnik
U.S. Nuclear Regulatory Commission
One White Flint North
11555 Rockville Pike
Rockville, MD 20832

Dear Mr. Masnik:

Subject: Oyster Creek Nuclear Generating Station
Docket 50-219
Sea Turtle Incidental Capture Report #92-1

actually second - first was a loggerhead on 6/25/92

This report provides detailed information regarding the recent impingement of a subadult Kemp's Ridley sea turtle at the Oyster Creek Nuclear Generating Station. The turtle was captured alive on 10-26-92, tagged and subsequently released at Kure Beach, North Carolina on 10-31-92.

If you have any questions or require additional information, please do not hesitate to contact Mr. Malcolm Browne of our Environmental Controls Department at (609) 971-4124.

Very truly yours,

John J. Barton
Vice President and Director
Oyster Creek

JJB/MB:jc
Enclosure

FILE

cc: Ms. Colleen C. Coogan
U.S. Department of Commerce
Nat'l Oceanic & Atmos. Admin.
National Marine Fisheries Ser.
Habitat Protected Res. Div.
One Blackburn Drive
Gloucester, MA 01930

OCNGS Sea Turtle Incidental Capture Report #92-1

October 26, 1992

During the early morning hours of Monday, October 26, 1992 an Oyster Creek Nuclear Generating Station (OCNGS) operator conducting a routine survey of the condenser intake area noticed a live Kemp's Ridley sea turtle impinged against the trash racks. The turtle was found with its head out of the water and pointing upward at about 0300 hours. The turtle was carefully removed as quickly as possible and found to be in good condition. OCNGS Environmental Controls personnel who took custody of the turtle confirmed its identification as a subadult Kemp's Ridley turtle and made arrangements for immediate transfer of the turtle to the Marine Mammal Stranding Center, Brigantine, NJ. The water temperature in the OCNGS intake canal at the time of the impingement was approximately 51°F (11.1°C) and OCNGS was in operation at full power. Although it was impossible to say precisely how long the turtle had been on the intake structure prior to removal, it may have been there between three and eight hours.

The turtle was transferred to Marine Mammal Stranding Center (MMSC) personnel at 0519 hours. It measured 12.6 in. (32.0 cm) carapace length straight line and weighed 12.5 lbs. (5.7 kg). Sex was not determined. No tags were present on the turtle when captured. MMSC personnel found the turtle to be very healthy. When released into the MMSC holding tanks, it swam freely and required no direct care. However, two scars from slash-like wounds were apparent on the plastron, indicating that the turtle had been wounded at some time prior to capture. USNRC and NMFS personnel were notified of the capture at the earliest opportunity (10-26-92).

Because of concerns that the turtle may be subject to cold stunning if released in New Jersey coastal waters, MMSC personnel made arrangements for the turtle to be transported to North Carolina prior to being released to ensure that cold stunning would not occur. The turtle was tagged and released on 10-31-92 at Kure Beach, NC (see Appendix I for additional details).

Appendix I

NMFS/SEFC COOPERATIVE MARINE TURTLE TAGGING PROGRAM
TAGGING DATA (REHABILITATED, NETTED, OR OTHER RELEASE)

Tag Number(s) (list all tag #'s and letter prefix): Left Front NNK 073; Rt. front NNK 074

Species: Kemp's Ridley (Lepidochelys kempi)

Date Released: 10-31-92

Describe release location (be specific - include county and lat/long if available):

Kure Beach, New Hanover County, North Carolina

(33°58'00" N. latitude, 77°55'02" W. longitude)

Describe original stranding or capture location **AND** stranding or capture date (where did this turtle come from?):

Oyster Creek Nuclear Generating Station, Ocean County, NJ

capture date 10-26-92

Describe capture method and/or type of gear in use when turtle was caught (if applicable):

Impinged on Oyster Creek NGS intake structure

Carapace length straight line	32.0	cm	12.6	in
Carapace width straight line		cm		in
Carapace length over curve		cm		in
Carapace width over curve		cm		in

Weight 5.7 kg 12.5 lbs

Additional remarks or data (use back if necessary):

Organization Tagging (**include area code/phone number**):

Marine Mammal Stranding Center, Brigantine, NJ (609) 266-0538

Mail completed forms to: NMFS - Miami Lab
Cooperative Marine Turtle Tagging Program
75 Virginia Beach Drive
Miami, FL 33149

U.S. DEPARTMENT OF COMMERCE

10/18/93

To : Colleen

From: Malcolm Browne
Oyster Creek Power Plant
NJ
(609) 971-4124

10/17 at noon took (dead) Kemp Ridley Turtle
(the first turtle take this year)

10.25 inches long

Notified USNRC

Report being prepared - cc to you

Question: What does he do with the body?

June '92 - ~~decomp~~ dead loggerhead propwounds

Marcia

Sep 9/11 '92 → Cc → released into discharge canal, returned dep later then to Bob S.

Oct 26th → L.K. → good condition, 51°F to MMSC → sent South to NC.

TRANSMITTAL FORM CD-82A (10-67)
PRESCRIBED BY DAO 214-2

JUN 27 1994

Nuclear

GPU Nuclear Corporation
Post Office Box 388
Route 9 South
Forked River, New Jersey 08731-0388
609 971-4000
Writer's Direct Dial Number:

6530-94-2071

June 21, 1994

Mr. Michael Masnik
U.S. Nuclear Regulatory Commission
One White Flint North
11555 Rockville Pike
Rockville, MD 20832

Dear Mr. Masnik:

Subject: Oyster Creek Nuclear Generating Station
Docket 50-219
Sea Turtle Incidental Capture Report 94-1

This report provides detailed information regarding the recent incidental capture of a juvenile loggerhead sea turtle at the Oyster Creek Nuclear Generating Station. The turtle was captured alive during the afternoon of 6-19-94 in front of the condenser intake structure. As indicated on the attached incident report, the turtle has been taken to the Marine Mammal Stranding Center in Brigantine, NJ, where it will be examined, tagged and released offshore as soon as possible.

If you have any questions or require additional information, please do not hesitate to contact Mr. Malcolm Browne of our Environmental Controls Department at (609) 971-4124.

Very truly yours,

for John J. Barton
Vice President and Director
Oyster Creek

Enclosure
cc: Mr. Douglas Beach
U.S. Department of Commerce
Nat'l Oceanic & Atmos. Admin.
National Marine Fisheries Ser.
Habitat Protected Res. Div.
One Blackburn Drive
Gloucester, MA 01930

Administrator, Region 1
Senior NRC Resident Inspector
Oyster Creek NRC Project Manager

Oyster Creek Nuclear Generating Station

Sea Turtle Incidental Capture Report 94-1

June 19, 1994

At approximately 1330 hours on Sunday, June 19, 1994, an Oyster Creek Nuclear Generating Station (OCNGS) operator conducting a routine survey of the intake area noticed a sea turtle swimming in the forebay immediately upstream of the condenser intake structure trash racks. The turtle was carefully removed as quickly as possible (at 1345 hours) and found to be active, healthy and with no apparent wounds. OCNGS Environmental Controls personnel who took custody of the turtle confirmed it to be a juvenile loggerhead turtle (Caretta caretta). At the time of the capture OCNGS was in operation at full power with 4 circulating water pumps and 2 dilution pumps operating. The water temperature in the OCNGS intake canal at the time of the capture was approximately 81°F (27.2°C). Although it was impossible to say precisely how long the turtle had been near the intake structure prior to removal, it is believed to have been in the vicinity for a relatively short period of time.

The turtle measured 14.5 in. (36.8 cm) carapace length straight line and weighed 21.6 lbs. (9.8 kg). Sex was not determined. No tags were present on the turtle when captured. No prominent scars or slash-like propeller wounds were apparent on the turtle. USNRC and NMFS personnel were notified of the capture at the earliest opportunity (6-20-94).

Within three to four hours after the time of its capture, the turtle was taken to the Marine Mammal Stranding Center (MMSC) in Brigantine, NJ. Personnel at MMSC will examine, tag and release the turtle offshore at the earliest opportunity.

AUG 1 1994 (KT)

Nuclear

GPU Nuclear Corporation
Post Office Box 388
Route 9 South
Forked River, New Jersey 08731-0388
609 971-4000
Writer's Direct Dial Number:

6530-94-2087
July 26, 1994

Mr. Michael Masnik
U.S. Nuclear Regulatory Commission
One White Flint North
11555 Rockville Pike
Rockville, MD 20832

Dear Mr. Masnik:

Subject: Oyster Creek Nuclear Generating Station
Docket 50-219
Sea Turtle Incidental Capture Reports 94-2 through 94-4

These reports provide detailed information regarding the recent impingement of sea turtles at the Oyster Creek Nuclear Generating Station. Dead juvenile Kemp's ridley turtles were captured July 1 and July 12, 1994 at the dilution structure trash racks. A dead subadult loggerhead turtle was also captured July 6 at the dilution structure trash racks. A necropsy was performed on the loggerhead turtle at the Marine Mammal Stranding Center; the results are included as an attachment to this report. The two Kemp's ridley turtles have been sent to experts at Cornell University to perform necropsies.

If you have any questions or require additional information, please do not hesitate to contact Malcolm Browne of our Environmental Affairs Department at (609) 971-4124.

Very truly yours,

for John J. Barton
Vice President and Director
Oyster Creek

JJB/MEB/ef
Enclosure
cc: Mr. Douglas Beach
U.S. Department of Commerce
Nat'l Oceanic & Atmos. Admin.
National Marine Fisheries Ser.
Habitat Protected Res. Div.
One Blackburn Drive
Gloucester, MA 01930

Mr. Dave Jenkins
NJDEP
Div. Fish/Game/Wldlf.
PO Box 236
Tuckahoe, NJ 08250

Administrator, Region 1
Senior NRC Resident Inspector
Oyster Creek NRC Project Manager
Document Control Desk

Oyster Creek Nuclear Generating Station

Sea Turtle Incidental Capture Report 94-2

July 1, 1994

At approximately 1000 hours on Friday, July 1, 1994, an Oyster Creek Nuclear Generating Station (OCNGS) operator conducting a routine survey of the intake area noticed a sea turtle during a routine cleaning of the dilution intake structure trash racks. The turtle was carefully removed as quickly as possible and found to be inactive and exhibited a strong odor of decomposition. OCNGS Environmental Affairs personnel who took custody of the turtle confirmed it to be a juvenile Kemp's ridley turtle (Lepidochelys kemp) and tried unsuccessfully to resuscitate it. At the time of the capture OCNGS was in operation at full power with 4 circulating water pumps and 2 dilution pumps operating. The water temperature in the OCNGS intake canal at the time of the capture was approximately 78.3°F (25.7°C). Although it was impossible to say precisely how long the turtle had been at the intake structure prior to removal, it is known that the intake bay in which the turtle was found was cleaned during the previous afternoon.

The turtle measured 10.9 in. (27.7 cm) carapace length straight line and weighed 8.0 lbs. (3.6 kg). Sex was not determined. No tags were present on the turtle when captured. No prominent scars or slash-like propeller wounds were apparent on the turtle. USNRC and NMFS personnel were notified of the capture at the earliest opportunity (7-1-94).

This turtle has been sent to marine turtle experts at the Center for the Environment, Cornell University, who will perform a thorough necropsy.

Oyster Creek Nuclear Generating Station

Sea Turtle Incidental Capture Report 94-3

July 6, 1994

At approximately 0615 hours on Wednesday, July 6, 1994, Oyster Creek Nuclear Generating Station (OCNGS) operators conducting routine cleaning of the dilution pump intake area removed a sea turtle from the dilution structure trash racks. OCNGS Environmental Affairs personnel who took custody of the turtle confirmed it to be a subadult loggerhead turtle (Caretta caretta) and tried unsuccessfully to resuscitate it. At the time of the capture OCNGS was in operation at full power with 4 circulating water pumps and 2 dilution pumps operating. The water temperature in the OCNGS intake canal at the time of the capture was approximately 80.5°F (26.9°C). Although it was impossible to say precisely how long the turtle had been at the intake structure prior to removal, the trash racks at the dilution intake had previously been cleaned 6-8 hours earlier.

The turtle measured 24.5 in. (61.4 cm) carapace length straight line and weighed 89.0 lbs. (40.4 kg). Sex was not determined. No tags were present on the turtle when captured. At least three deep scars or slash-like propeller wounds were apparent on the turtle. These scars were not fresh because blue mussels were attached and growing in these scars. USNRC and NMFS personnel were notified of the capture at the earliest opportunity (7-6-94).

Several hours after the time of its capture, the turtle was taken to the Marine Mammal Stranding Center (MMSC) in Brigantine, NJ. Robert Schoelkopf, MMSC Director, performed a necropsy of the carcass (see attached MMSC Stranding Report). Mr. Schoelkopf reported that the turtle did not die at the intake and did not suffocate. The lungs were found to be in good condition. The turtle was believed to have died one to two days prior to arriving at OCNGS, probably due to a longterm illness. A large notch along the left perimeter of the turtle's carapace, as well as deterioration of all four appendages, were attributed by Schoelkopf to bacterial or fungal infections.

SEA TURTLE STRANDING AND SALVAGE NETWORK - STRANDING REPORT

PLEASE PRINT CLEARLY AND FILL IN ALL APPLICABLE BLANKS. Use codes below. Measurements may be straight line (caliper) and/or over the curve (tape measure). Measure length from the center of the nuchal notch to the tip of the most posterior marginal. Measure width at the widest point of carapace. **CIRCLE THE UNITS USED.** See diagram below. Please give a specific location description. **INCLUDE LATITUDE AND LONGITUDE.**

Observer's Full Name: MARINE MAMMAL STRANDING CENTER — Stranding Date: 94 (year) - 07 (month) - 06 (day)

Address / Affiliation: Brigantine, N.J.

Area Code / Phone Number: 609-266-0538

Species: CC (Loggerhead) — Turtle Number By Day: 94-060

Reliability of I.D.: (CIRCLE) Unsure Probable **(Positive)** — Species Verified by State Coordinator? Yes ☒ No ☐

Sex: (CIRCLE) **(Female)** Male Undetermined — How was sex determined? Necropsy

State: NEW JERSEY — County: Ocean

Location (be specific and include closest town): Oyster Creek Nuclear Power Plant. Forked River

Latitude: 39 48' 52" — Longitude: 74 12' 05"

Condition of Turtle (use codes): 1 — Final Disposition of Turtle (use codes): 3

Tag Number(s) (include tag return address and disposition of tag): NA

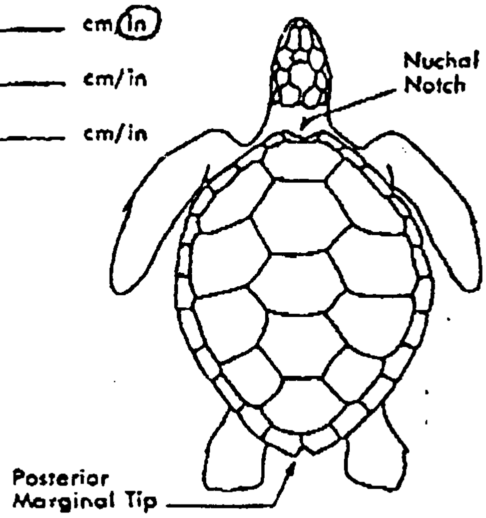
Remarks (note if turtle was involved with tar or oil, gear or debris entanglement, wounds or mutilations, propellor damage, papillomas, epizoa, etc.) continue on back if necessary

Carapace deteriorated due to fungal growth, All four appendages deteriorated (possible bacterial infection) Photos taken, Stomach and esophogase contained blue crabs, no tag scars, Field # 94-060

MEASUREMENTS: CIRCLE UNITS

Straight Length	24.5	cm / **(in)**
Straight Width	19.75	cm / **(in)**
Curved Length		cm/in
Curved Width		cm/in

Mark wounds, abnormalities, and tag locations



CODES:

SPECIES:
- CC = Loggerhead
- CM = Green
- DC = Leatherback
- EI = Hawksbill
- LK = Kemp's ridley
- UN = Unidentified

CONDITION OF TURTLE:
- 0 = Alive
- 1 = Fresh dead
- 2 = Moderately decomposed
- 3 = Severely decomposed
- 4 = Dried carcass
- 5 = Skeleton, bones only

FINAL DISPOSITION OF TURTLE:
- 1 = Painted, left on beach
- 2 = Buried: on beach / off beach
- 3 = Salvaged specimen: all / part
- 4 = Pulled up on beach or dune
- 5 = Unpainted, left on beach
- 6 = Alive, released
- 7 = Alive, taken to a holding facility

Oyster Creek Nuclear Generating Station

Sea Turtle Incidental Capture Report 94-4

July 12, 1994

At approximately 2240 hours on Tuesday, July 12, 1994, Oyster Creek Nuclear Generating Station (OCNGS) operators conducting routine cleaning of the dilution intake trash racks removed a sea turtle from the trash racks. The turtle was found to be inactive but had no apparent wounds. OCNGS Environmental Affairs personnel who took custody of the turtle confirmed it to be a juvenile Kemp's ridley turtle (Lepidochelys kemp) and tried unsuccessfully to resuscitate it. At the time of the capture OCNGS was in operation at full power with 4 circulating water pumps and 2 dilution pumps operating. The water temperature in the OCNGS intake canal at the time of the capture was approximately 83°F (28.4°C). Although it was impossible to say precisely how long the turtle had been at the intake structure prior to removal, it may have been there for up to several hours.

The turtle measured 10.5 in. (26.7 cm) carapace length straight line and weighed 7.3 lbs. (3.3 kg). Sex was not determined. No tags were present on the turtle when captured. No prominent scars or slash-like propeller wounds were apparent on the turtle. USNRC and NMFS personnel were notified of the capture at the earliest opportunity (7-13-94).

This turtle has been sent to marine turtle experts at the Center for the Environment, Cornell University, who will perform a thorough necropsy.

1514-05A NRC Oyster Creek

GPU NUCLEAR

GPU Nuclear, Inc.
U.S. Route #9 South
Post Office Box 388
Forked River, NJ 08731-0388
Tel 609-971-4000

6530-972-1751

October 2, 1997

Mr. John Moulton
U.S. Nuclear Regulatory Commission
One White Flint North
11555 Rockville Pike
Rockville, MD 20832

Dear Mr. Moulton,

Subject: Oyster Creek Nuclear Generating Station
Docket 50-219
Sea Turtle Incidental Capture Report 97-1

This report provides detailed information regarding the recent incidental capture of a subadult Kemp's ridley sea turtle at the Oyster Creek Nuclear Generating Station. The turtle was captured dead during the early morning of September 4, 1997, at the dilution structure trash racks. As indicated on the attached incident report, the turtle has been kept in a freezer for temporary storage at our on-site biological laboratory. This is the first incidental capture of a sea turtle at Oyster Creek since July of 1994.

If you have any questions or require additional information, please do not hesitate to contact Mr. Malcolm Browne of our Environmental Affairs Department at (609) 971-4124.

Very truly yours,

Michael B. Roche

Michael B. Roche
V. P. & Director
OCNGS

MAB/mmj
Enclosure
cc: Ms. Kim Thounhurst
U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Marine Fisheries Service
Habitat and Protected Resources Division
One Blackburn Drive
Gloucester, MA 01930-2298

FILE

C: Administrator, Region 1
OCNGS NRC Project Manager
Document Control Desk - NRC
US Nuclear Regulatory Commission
One White Flint North
11555 Rockville Pike
Rockville, MD 20832

Mr. Dave Jenkins
NJ Department of Environmental Protection
Division of Fish, Game, and Wildlife
P.O. Box 236
Tuckahoe, N.J. 08250

OCNGS NRC Resident Inspector, OC SEB

Oyster Creek Nuclear Generating Station

Sea Turtle Incidental Capture Report 97-1

September 4, 1997

At approximately 0318 hours on Thursday, September 4, 1997, an Oyster Creek Nuclear Generating Station (OCNGS) operator removing eelgrass from the dilution trash racks noticed a sea turtle among the debris in front of the trash rack in Bay # 6 of the dilution intake structure. The turtle was carefully removed as quickly as possible using a dip net and found to be limp, immobile and with no apparent breathing. OCNGS Environmental Affairs personnel who took custody of the turtle confirmed it to be a subadult Kemp's ridley (Lepidochelys kempi). The water temperature at the time of the incidental capture was approximately 73.2 F (22.9 C) and OCNGS was in operation at full power with four circulating water pumps and two dilution pumps in operation. Although it is impossible to say precisely how long the turtle had been on the intake structure prior to removal, the dilution trash racks had been mechanically cleaned less than five hours earlier (i.e., September 3 at 2230 hours)

The turtle measured 19.0 in (48.8 cm) carapace length straight line and weighed 40 lb (18.1 kg). Sex was not determined. No tags were present on the turtle when captured. The only external damage exhibited was two dorsal scutes that were broken or missing. The damage to the dorsal scutes may have occurred during removal of the turtle from the dilution intake area or it may have occurred prior to capture. USNRC and NMFS personnel were notified of the capture within 24 hours on September 4, 1997.

After the turtle was examined by Environmental Affairs personnel, it was placed in a freezer for temporary storage at our on-site biological laboratory.

GPU NUCLEAR

GPU Nuclear, Inc.
U.S. Route #9 South
Post Office Box 388
Forked River, NJ 08731-0388
Tel 609-971-4000

6530-982-2135

AUG 25 1998

Ms. Claudia Craig (by cert. mail RRR#Z 051 941 124)
U.S. Nuclear Regulatory Commission
Mailstop O-10-H-5
Washington, DC 20555

Dear Ms. Craig,

Subject: Oyster Creek Nuclear Generating Station
Docket 50-219
Sea Turtle Incidental Capture Report 98-1

This report provides detailed information regarding the recent incidental capture of a subadult loggerhead sea turtle at the Oyster Creek Nuclear Generating Station. The turtle was captured alive during the morning of August 18, 1998 at the circulating water intake structure trash racks. As indicated on the attached incident report, the turtle has been transferred to the Marine Mammal Stranding Center in Brigantine, NJ for rehabilitation. This is only the second incidental capture of a sea turtle at Oyster Creek since August of 1994.

If you have any questions or require additional information, please do not hesitate to contact Mr. Malcolm Browne of our Environmental Affairs Department at (609) 971-4124.

Very truly yours,

Michael B Roche

Michael B. Roche
V. P. & Director
OCNGS

MAB/ars
Enclosure
cc: Ms. Nancy Haley (by cert. mail RRR# Z 051 941 127)
U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Marine Fisheries Service
Habitat and Protected Resources Division
One Blackburn Drive
Gloucester, MA 01930

cc: Hub Miller (by cert. mail RRR# Z 051 941 128)
Administrator, Region 1
US Nuclear Regulatory Commission
475 Allendale Road
King of Prussia, PA 19406

Ron Eaton (by cert. mail RRR# Z051 941 129)
Senior Project Manager
US Nuclear Regulatory Commission
Washington, DC 20555

US Nuclear Regulatory Commission (by cert. mail RRR# Z 051 941 130)
Document Control Desk - NRC
Washington, DC 20555

Mr. Dave Jenkins (by cert. mail RRR# Z 051 941 126)
NJ Department of Environmental Protection
Division of Fish, Game, and Wildlife
P.O. Box 236
Tuckahoe, NJ 08250

OCNGS NRC Resident Inspector, OC SEB

Oyster Creek Nuclear Generating Station

Sea Turtle Incidental Capture Report 98-1

<u>August 18, 1998</u>

At approximately 0959 hours on Tuesday, August 18, 1998, an Oyster Creek Nuclear Generating Station (OCNGS) operator noticed a sea turtle in front of the trash rack in Bay # 4 of the circulating water intake structure. The turtle was carefully removed as quickly as possible using a sea turtle dip net and found to be alive and moving about actively. However, a length of several feet of fish netting was wrapped tightly around the right front flipper of the turtle, causing restricted circulation and movement of that limb. It was apparent from the atrophied and partially decayed condition of the right front flipper that the turtle had been entangled in the fish netting long before its incidental capture. OCNGS Environmental Affairs personnel who took custody of the turtle confirmed it to be a subadult loggerhead (<u>Caretta caretta</u>). The water temperature at the time of the incidental capture was approximately 80.5 F (26.9 C) and OCNGS was in operation at full power with four circulating water pumps and two dilution pumps in operation. Although it is impossible to say precisely how long the turtle had been near the intake structure prior to removal, the intake trash racks had been mechanically cleaned the previous afternoon.

The turtle measured 20.0 in (50.8 cm) carapace length straight line and weighed 53.9 lb (24.4 kg). Sex was not determined. No tags were present on the turtle when captured.

After the turtle was examined by Environmental Affairs personnel, it was transferred to the Marine Mammal Stranding Center (MMSC) in Brigantine, NJ. MMSC personnel then began to locate a facility where the turtle can receive appropriate medical treatment and rehabilitation prior to eventually being released in the ocean. Sea World of Orlando, FL has indicated they will provide these services. The turtle was transported to Sea World August 21, 1998.

USNRC and NMFS personnel were notified of the incidental capture within 24 hours on August 18, 1998.

OPTIONAL FORM 99 (7-90)

FAX TRANSMITTAL	# of pages ► 1
To Laurie	From Nancy
Dept./Agency FYI	Phone #
Fax # (978) 281 · 9394	Fax # 203 · 783 · 4295

NSN 7540-01-317-7368 5099-101 GENERAL SERVICES ADMINISTRATION

GPU NUCLEAR

GPU Nuclear, Inc.
U.S. Route #9 South
Post Office Box 388
Forked River, NJ 08731-0388
Tel 609-971-4000

6530-982-2418
SEP 27 1999

U.S. Nuclear Regulatory Commission
Mr. Barry Zalcman, Mailstop O-11-F1
(by cert. mail RRR#Z 051 947 427)
Sea Turtle Coordinator
Washington, DC 20555

Dear Mr. Zalcman,

Subject: Oyster Creek Nuclear Generating Station
Docket 50-219
Sea Turtle Incidental Capture Report 99-1

This report provides detailed information regarding the recent incidental capture of a subadult Kemp's ridley sea turtle at the Oyster Creek Nuclear Generating Station. The turtle was captured alive during the morning of September 23, 1999 at the dilution intake structure trash racks. As indicated on the attached incident report, the turtle has been transferred to the Marine Mammal Stranding Center in Brigantine, NJ. This is only the third incidental capture of a sea turtle at Oyster Creek since August of 1994.

If you have any questions or require additional information, please do not hesitate to contact Mr. Malcolm Browne of our Environmental Affairs Department at (609) 971-4124.

Very truly yours,

Michael B Roche

Michael B. Roche
V. P. & Director
OCNGS

MBR/MAB/ew
Enclosure
cc: Ms. Mary Colligan (by cert. mail RRR# Z 051 947 428)
U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Marine Fisheries Service
Habitat and Protected Resources Division
One Blackburn Drive
Gloucester, MA 01930

cc: Mr. Hubert Miller (by cert. mail RRR# Z 051 947 429)
Administrator, Region 1
US Nuclear Regulatory Commission
475 Allendale Road
King of Prussia, PA 19406

US Nuclear Regulatory Commission
Ms. Helen N. Pastis, Mailstop O-8-B1
(by cert. mail RRR# Z051 947 430)
Washington, DC 20555

US Nuclear Regulatory Commission (by cert. mail RRR# Z 051 947 431)
Document Control Desk - NRC
Washington, DC 20555

Mr. Dave Jenkins (by cert. mail RRR# Z 051 947 432)
NJ Department of Environmental Protection
Division of Fish, Game, and Wildlife
P.O. Box 236
Tuckahoe, NJ 08250

OCNGS NRC Resident Inspector, OC SEB

Oyster Creek Nuclear Generating Station

Sea Turtle Incidental Capture Report 99-1

September 23, 1999

At approximately 0310 hours on Thursday, September 23, 1999, an Oyster Creek Nuclear Generating Station (OCNGS) operator removed a sea turtle in front of the trash rack in Bay # 4 of the dilution water intake structure. The turtle was carefully removed from the trash racks with a trash rake, and found to be alive and moving about actively. OCNGS Environmental Affairs personnel who took custody of the turtle confirmed it to be a subadult Kemp's ridley *(Lepidochelys kempi).* The water temperature at the time of the incidental capture was approximately 67.2 F (19.6 C) and OCNGS was in operation at full power with four circulating water pumps and two dilution pumps operating. Although it is impossible to say precisely how long the turtle had been near the intake structure prior to removal, the intake trash racks had been mechanically cleaned the previous day.

The turtle measured 10.3 in (26.4 cm) carapace length straight line and weighed 6.3 lb (2.9 kg). Sex was not determined. No tags were present on the turtle when captured.

After the turtle was examined by Environmental Affairs personnel, it was transferred to the Marine Mammal Stranding Center (MMSC) in Brigantine, NJ. MMSC personnel then began to locate a facility in a warmer climate to which the turtle can be transferred prior to eventually being released in the ocean.

USNRC and NMFS personnel were notified of the incidental capture within 24 hours on September 23, 1999.

GPU NUCLEAR

GPU Nuclear, Inc.
U.S. Route #9 South
Post Office Box 388
Forked River, NJ 08731-0388
Tel 609-971-4000

6530-992-2429
NOV 0 1 1999

U.S. Nuclear Regulatory Commission
Mr. Barry Zalcman, Mailstop O-11-F1
(by cert. mail RRR#Z 051 947 447)
Sea Turtle Coordinator
Washington, DC 20555

Dear Mr. Zalcman,

Subject: Oyster Creek Nuclear Generating Station
Docket 50-219
Sea Turtle Incidental Capture Report 99-2

This report provides detailed information regarding the recent incidental capture of a subadult green sea turtle at the Oyster Creek Nuclear Generating Station. The turtle was captured dead during the morning of October 23, 1999 at the dilution intake structure trash racks. As indicated on the attached incident report, arrangements are being made to send the turtle to Cornell University, Ithaca, NY, for a necropsy. This is only the fourth incidental capture of a sea turtle at Oyster Creek since August of 1994 and the first green sea turtle ever captured at Oyster Creek..

If you have any questions or require additional information, please do not hesitate to contact Mr. Malcolm Browne of our Environmental Affairs Department at (609) 971-4124.

Very truly yours,

Michael B Roche

Michael B. Roche
V. P. & Director
OCNGS

MBR/MAB/ew
Enclosure
cc: Ms. Mary Colligan (by cert. mail RRR# Z 051 947 448)
U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Marine Fisheries Service
Habitat and Protected Resources Division
One Blackburn Drive
Gloucester, MA 01930

cc: Mr. Hubert Miller (by cert. mail RRR# Z 051 947 449)
Administrator, Region 1
US Nuclear Regulatory Commission
475 Allendale Road
King of Prussia, PA 19406

US Nuclear Regulatory Commission
Ms. Helen N. Pastis, Mailstop O-8-B1
(by cert. mail RRR# Z051 947 450)
Washington, DC 20555

US Nuclear Regulatory Commission (by cert. mail RRR# Z 051 947 451)
Document Control Desk - NRC
Washington, DC 20555

Mr. Dave Jenkins (by cert. mail RRR# Z 051 947 452)
NJ Department of Environmental Protection
Division of Fish, Game, and Wildlife
P.O. Box 400
Trenton, NJ 08625-0400

OCNGS NRC Resident Inspector, OC SEB

Oyster Creek Nuclear Generating Station

Sea Turtle Incidental Capture Report 99-2

October 23, 1999

At approximately 0200 hours on Saturday, October 23, 1999, an Oyster Creek Nuclear Generating Station (OCNGS) operator removed a sea turtle in front of the trash rack in Bay # 4 of the dilution water intake structure. The turtle was carefully removed from the trash racks with a trash rake, and found to be inactive and either dead or comatose. Attempts were made to resuscitate the turtle for several hours after the incidental capture, but the attempts were unsuccessful. OCNGS Environmental Affairs personnel who took custody of the turtle confirmed it to be an immature green sea turtle *(Chelonia mydas)*. The water temperature at the time of the incidental capture was approximately 62.8 F (17.1 C) and OCNGS was in operation at full power with four circulating water pumps and two dilution pumps operating. Although it is impossible to say precisely how long the turtle had been near the intake structure prior to removal, the intake trash racks had been mechanically cleaned the previous day.

The turtle measured 10.6 in (27.0 cm) carapace length straight line and weighed 6.1 lb (2.75 kg). Sex was not determined. No tags were present on the turtle when captured.

The cause of death was not immediately apparent. There were no obvious boat propeller wounds and no open wounds that would have been life threatening. After the turtle was examined by Environmental Affairs personnel, arrangements were made for it to be examined further by Dr. Steven Morreale, a Cornell University sea turtle expert who has conducted numerous necropsies on sea turtles in the past.

USNRC and NMFS personnel were notified of the incidental capture the following workday.

TLU

GPU NUCLEAR

GPU Nuclear, Inc.
U.S. Route #9 South
Post Office Box 388
Forked River, NJ 08731-0388
Tel 609-971-4000

6530-002-2541

JUN 29 2000

U.S. Nuclear Regulatory Commission
Mr. James Wilson, Mailstop O-11-F1
(by cert. mail RRR#Z 397 062 895)
Sea Turtle Coordinator
Washington, DC 20555

Dear Mr. Wilson,

Subject: Oyster Creek Nuclear Generating Station
Docket 50-219
Sea Turtle Incidental Capture Report 2000-1

This report provides detailed information regarding the recent incidental capture of a juvenile loggerhead sea turtle at the Oyster Creek Nuclear Generating Station. The turtle was captured alive and apparently unharmed during the early morning of June 23, 2000 at the dilution intake structure trash bars. As indicated on the attached incident report, the turtle has been taken to the Marine Mammal Stranding Center in Brigantine, NJ for examination, care and eventual safe release to offshore Atlantic Ocean waters.

If you have any questions or require additional information, please do not hesitate to contact Mr. Malcolm Browne of our Environmental Affairs Department at (609) 971-4124.

Very truly yours,

Sander Levin
Acting Site Director
Oyster Creek Nuclear Generating Station

SL/MEB/ew
Enclosure
cc: Ms. Mary Colligan (by cert. mail RRR# Z 397 062 896)
U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Marine Fisheries Service
Habitat and Protected Resources Division
One Blackburn Drive
Gloucester, MA 01930
Mr. James Wilson

RECEIVED
JUL - 6 2000

6530-002-2541

cc: Mr. Hubert Miller (by cert. mail RRR# Z 397 062 897)
Administrator, Region 1
US Nuclear Regulatory Commission
475 Allendale Road
King of Prussia, PA 19406

US Nuclear Regulatory Commission
Ms. Helen N. Pastis, Mailstop O-8-B1
(by cert. mail RRR# Z 397 062 898)
Washington, DC 20555

US Nuclear Regulatory Commission (by cert. mail RRR# Z 397 062 899)
Document Control Desk - NRC
Washington, DC 20555

Mr. Dave Jenkins (by cert. mail RRR# Z 397 062 900)
NJ Department of Environmental Protection
Division of Fish, Game, and Wildlife
P.O. Box 400
Trenton , NJ 08625-0400

OCNGS NRC Resident Inspector, OC SEB

Oyster Creek Nuclear Generating Station

Sea Turtle Incidental Capture Report 2000-1

June 23, 2000

At approximately 0120 hours on June 23, 2000, an Oyster Creek Nuclear Generating Station (OCNGS) operator removed a live sea turtle from in front of the trash bars in Bay #1 of the dilution water intake structure. The turtle was carefully removed from the trash bars with a sea turtle dipnet, and found to be very active and with no visible wounds or signs of injury. OCNGS Environmental Affairs personnel who took custody of the turtle confirmed it to be a juvenile loggerhead (*Caretta caretta*). The water temperature at the time of the incidental capture was approximately 77.5 F (25.3 C) and OCNGS was in operation at full power with four circulating water pumps and two dilution pumps operating. Although it is impossible to say precisely how long the turtle had been near the intake structure prior to removal, the intake trash racks had been mechanically cleaned the previous day.

The turtle measured 18.8 in (47.8 cm) straight line carapace length, 17 in (43.2 cm) carapace width and weighed approximately 38 lb (17.2 kg). Sex was not determined. No tags were present on the turtle when captured.

After the turtle was examined by Environmental Affairs personnel, arrangements were made for it to be transferred to the Marine Mammal Stranding Center (MMSC) in Brigantine, NJ. MMSC personnel examined, fed and tagged the turtle. It was released to safety in the Atlantic Ocean offshore of Brigantine, NJ on June 26.

USNRC and NMFS personnel were notified of the incidental capture within 24 hours on June 23, 2000.

GPU NUCLEAR

GPU Nuclear, Inc.
U.S. Route #9 South
Post Office Box 388
Forked River, NJ 08731-0388
Tel 609-971-4000

6530-002-2549
JUL 3 1 2000

US Nuclear Regulatory Commission
(by cert. mail RRR# Z 397 062 916)
Document Control Desk - NRC
Washington, DC 20555

Dear Sirs,

Subject: Oyster Creek Nuclear Generating Station
Docket 50-219
Sea Turtle Incidental Capture Report 2000-2

This report provides detailed information regarding the recent incidental capture of a juvenile Kemp's ridley sea turtle at the Oyster Creek Nuclear Generating Station. The turtle was captured dead during the afternoon of July 2, 2000 at the dilution intake structure trash bars. As indicated on the attached incident report, the turtle has been kept in a freezer for temporary storage at our on-site biological laboratory until arrangements can be made to have a necropsy performed on it.

If you have any questions or require additional information, please do not hesitate to contact Mr. Malcolm Browne of our Environmental Affairs Department at (609) 971-4124.

Very truly yours,

Sander Levin
Acting Site Director
Oyster Creek Nuclear Generating Station

SL/MEB/ew
Enclosure
cc: Ms. Mary Colligan (by cert. mail RRR# Z 397 062 913)
U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Marine Fisheries Service
Habitat and Protected Resources Division
One Blackburn Drive
Gloucester, MA 01930

Oyster Creek Nuclear Generating Station

Sea Turtle Incidental Capture Report 2000-2

July 2, 2000

At approximately 1500 hours on Sunday, July 2, 2000, an Oyster Creek Nuclear Generating Station (OCNGS) operator performing a routine inspection of the dilution trash racks noticed a sea turtle floating into the trash bars in Bay # 1 of the dilution intake structure. The turtle was carefully removed as quickly as possible and found to be limp, immobile and with no apparent breathing. OCNGS Environmental Affairs personnel who took custody of the turtle confirmed it to be a juvenile Kemp's ridley (*Lepidochelys kempi*). Repeated attempts to resuscitate the turtle were unsuccessful. The water temperature at the time of the incidental capture was approximately 78.1 F (25.6 C) and OCNGS was in operation at full power with four circulating water pumps and two dilution pumps in operation. Although it is impossible to say precisely how long the turtle had been on the intake structure prior to removal, the dilution trash racks had been mechanically cleaned the previous evening (i.e., July 1 at 2130 hours).

The turtle measured 10.75 in (27.3 cm) carapace length straight line and weighed 7.1 lb (3.2 kg). Sex was not determined. No tags were present on the turtle when captured. The only external damage exhibited was two dorsal scutes that appeared to have superficial scrape marks. The damage to the dorsal scutes may have occurred during removal of the turtle from the dilution intake area or it may have occurred prior to capture. USNRC and NMFS personnel were notified of the capture within 24 hours on July 3, 2000.

After the turtle was examined by Environmental Affairs personnel, it was placed in a freezer for temporary storage at our on-site biological laboratory until arrangements can be made to have a necropsy performed on it.

cc: Mr. Hubert Miller (by cert. mail RRR# Z 397 062 914)
Administrator, Region 1
US Nuclear Regulatory Commission
475 Allendale Road
King of Prussia, PA 19406

US Nuclear Regulatory Commission
Ms. Helen N. Pastis, Mailstop O-8-B1
(by cert. mail RRR# Z 397 062 915)
Washington, DC 20555

US Nuclear Regulatory Commission
Mr. James Wilson, Mailstop O-11-F1
(by cert. mail RRR#Z 397 062 912)
Washington, DC 20555

Mr. Dave Jenkins (by cert. mail RRR# Z 397 062 917)
NJ Department of Environmental Protection
Division of Fish, Game, and Wildlife
P.O. Box 400
Trenton , NJ 08625-0400

OYSTER CREEK GENERATING STATION

Sea Turtle Incidental Capture Report 2000-3

August 3, 2000

At approximately 1525 hours on Thursday August 3, 2000, an Oyster Creek Generating Station (OCGS) operator performing a routine inspection of the dilution trash racks noticed a live sea turtle in Bay # 4 of the dilution intake structure. The turtle was carefully removed as quickly as possible and found to be alive, moving about normally and with no apparent injury. OCGS Environmental Affairs personnel who took custody of the turtle confirmed it to be a juvenile Atlantic green sea turtle (*Chelonia mydas*). The water temperature at the time of the incidental capture was approximately 83.9 F (28.8 C) and OCGS was in operation at full power with four circulating water pumps and two dilution pumps in operation. Although it is impossible to say precisely how long the turtle had been on the intake structure prior to removal, the dilution trash racks had been mechanically cleaned earlier the same day.

The turtle measured 11.5 in (29.2 cm) carapace length straight line and weighed 7.6 lb (3.4 kg). Sex was not determined. No tags were present on the turtle when captured. The majority of the dorsal surface of the turtle was heavily encrusted with barnacles. Several marginal scutes on the posterior dorsal surface had a dull grayish coloration, which may be an indication of a fungal infection. USNRC and NMFS personnel were notified of the capture within 24 hours on August 4, 2000.

The turtle was transferred to the Marine Mammal Stranding Center in Brigantine, NJ on August 3, 2000, where it was examined and given initial care. It was transferred on September 7, 2000 to the Karen Beasley Sea Turtle Rescue and Rehabilitation Center in Topsail Island, NC for final care before release. It was released October 12, 2000 in the Atlantic Ocean off Topsail Beach, NC.

OYSTER CREEK GENERATING STATION

Sea Turtle Incidental Capture Report 2000-4

At approximately 0112 hours on Monday August 28, 2000, an Oyster Creek Generating Station (OCGS) operator performing a routine inspection of the dilution trash racks noticed a live sea turtle in Bay # 1 of the dilution intake structure. The turtle was carefully removed as quickly as possible and found to be alive, moving about normally and with no apparent injury. OCGS Environmental personnel who took custody of the turtle confirmed it to be a juvenile Kemp's ridley sea turtle (Lepidochelys kempii). The water temperature at the time of the incidental capture was approximately 79.8 F (26.5 C) and OCGS was in operation at 72% power with four circulating water pumps and two dilution pumps in operation. The turtle measured 10.3 in (26.2 cm) carapace length straight line and weighed 6.5 lb (2.9 kg). Sex was not determined. No tags were present on the turtle when captured. Although it is impossible to say precisely how long the turtle had been on the intake structure prior to removal, the dilution trash racks had been mechanically cleaned the previous day and inspected earlier the same night that the turtle was captured.

The turtle was taken to the Marine Mammal Stranding Center (MMSC) in Brigantine, NJ. At the MMSC, the turtle was examined, fed, tagged and given initial care. The turtle was transferred on September 7, 2000 to the Karen Beasley Sea Turtle Rescue and Rehabilitation Center in Topsail Island, NC, where it is receiving final care prior to being released to safety in offshore Atlantic Ocean waters. USNRC and NMFS personnel were notified of the capture within 24 hours on August 28, 2000.

OYSTER CREEK GENERATING STATION

Sea Turtle Incidental Capture Report 2000-5

At approximately 1310 hours on Monday September 18, 2000, an Oyster Creek Generating Station (OCGS) operator performing a routine inspection of the trash racks noticed a live sea turtle in Bay # 4 of the circulating water intake structure. The turtle was carefully removed as quickly as possible and found to be alive, moving about normally and with no apparent injury. OCGS Environmental personnel who took custody of the turtle confirmed it to be a subadult loggerhead sea turtle (Caretta caretta). The water temperature at the time of the incidental capture was approximately 68.8 F (20.4 C) and OCGS was in operation at full power with four circulating water pumps and two dilution pumps in operation. Although it is impossible to say precisely how long the turtle had been on the intake structure prior to removal, the circulating water trash racks had been cleaned the previous afternoon.

The turtle measured 22.5 in (57.2 cm) carapace length straight line and weighed 58.5 lb (26.5 kg). Sex was not determined. No tags were present on the turtle when captured. The majority of the dorsal surface of the turtle was heavily encrusted with barnacles. A few of the scutes on the posterior dorsal surface had partially peeled, which may have occurred when some barnacles scraped off of the turtle. USNRC and NMFS personnel were notified of the capture within 24 hours on September 18, 2000.

The turtle was taken to the Marine Mammal Stranding Center (MMSC) in Brigantine, NJ. At the MMSC, the turtle was examined, fed, and tagged. The turtle was taken during late September to a more southerly location in Nags Head, NC (where cold-stunning was less likely) and released into the Atlantic Ocean.

APPENDIX III
Incident Report of Sea Turtle Take - OCNGS

Photographs should be taken and the following information should be collected from all turtles (alive and dead) found in association with the OCNGS. Please submit all necropsy results (including sex and stomach contents) to NMFS upon receipt.

Observer's full name: Ernest Weihrecht
Reporter's full name: Malcolm Browne

Species Identification (Key attached): L. kempi (Kemp's ridley)

Site of Impingement (CWS or DWS, Bay #, etc.): DWS Bay # 6

Date animal observed: 8-14-01 Time animal observed: 0334 hrs
Date animal collected: 8-14-01 Time animal collected: 0334 hrs
Date rehab facility contacted: 8-14-01 Time rehab facility contacted: 1015 hrs
Date animal picked up: 8-14-01 Time animal picked up: 1530 hrs

Environmental conditions at time of observation (i.e., tidal stage, weather): Intake canal turbidity high due to extremely heavy thunderstorms prior evening

Date and time of last inspection of screen: 8-14-01 0245 hrs

Water temperature (°C) at site and time of impingement: 27.8°C (82.0°F)

Intake velocity at site and time of impingement (ft/sec): 2.4 ft/sec (73 cm/sec)

Average percent of power generating capacity achieved per unit over the 48 hours previous to impingement: 98%

Sea Turtle Information: *(please designate cm/m or inches)*

Fate of animal (circle one): (dead) alive

Condition of animal (*include comments on injuries, whether the turtle is healthy or emaciated, general behavior while at OCNGS*): Appears fresh dead; no obvious boat propeller wounds. Several scutes superficially scraped near carapace centerline. Posterior marginal scutes scraped.
(please complete attached diagram)

Carapace length - Curved: ______ Straight: 9.0 in (22.8 cm)

Carapace width - Curved: ______ Straight: 8.4 in (21.4 cm)

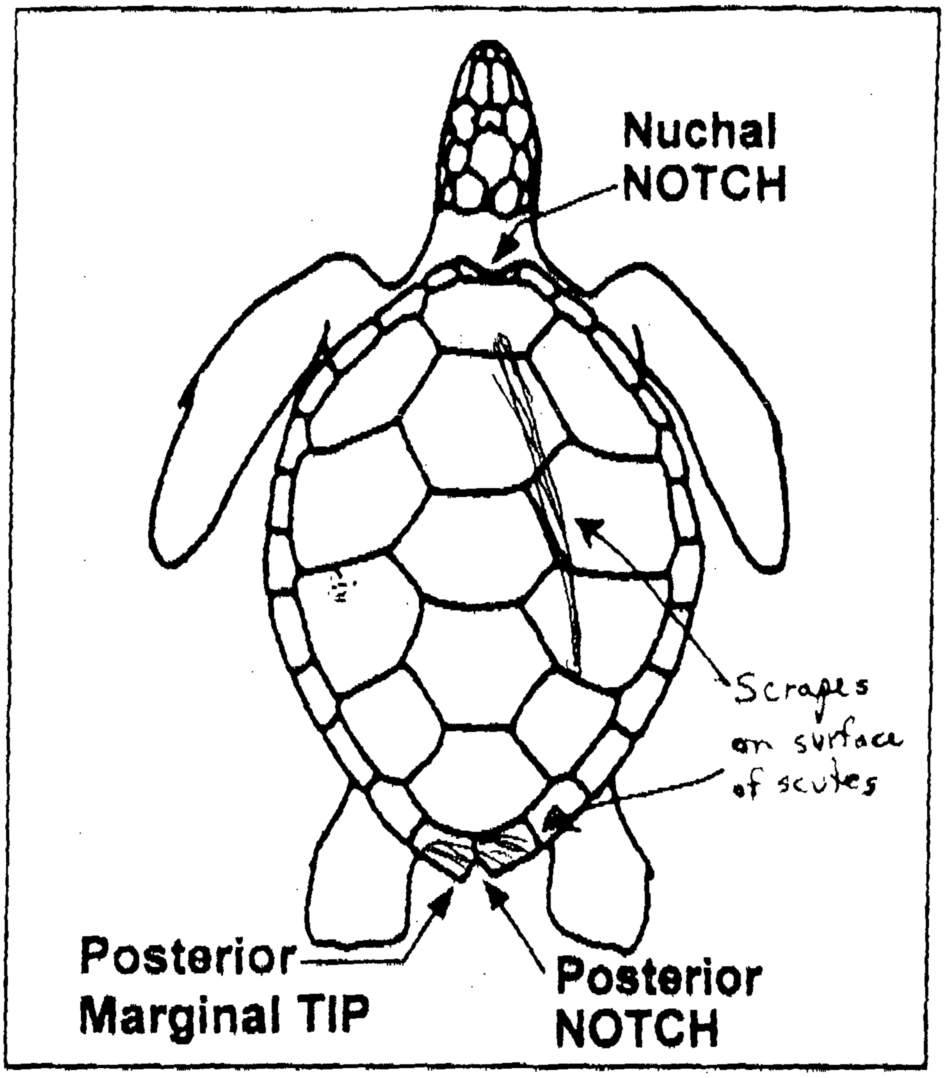
Existing tags?: YES / (NO) *Please record all tag numbers.* Tag # ______
Photograph attached: (YES) / NO
(please label *species, date, location of impingement* on back of photograph)

All information should be sent to the following address:

National Marine Fisheries Service Northeast Region
Protected Resources Division
One Blackburn Drive
Gloucester, MA 01930
Attention: Carrie McDaniel

APPENDIX III, continued (**Incident Report of Sea Turtle Take**)

Draw wounds, abnormalities, tag locations on diagram and briefly describe below.



Description of animal: Animal dead at time of capture but appeared relatively fresh. No tags present. No obvious boat propeller wounds, but there are several scutes with surficial scrapes near carapace centerline and posterior notch.

File Oyster Creek NRC

AmerGen

An Exelon/British Energy Company

AmerGen Energy Company, LLC
Oyster Creek
US Route 9 South
P.O. Box 388
Forked River, NJ 08731-0388

December 26, 2002
2130-02-20353
2120-022-2745

National Marine Fisheries Service Northeast Region
Protected Resources Division
One Blackburn Drive
Gloucester, MA 01930
Attention: Carrie McDaniel

Subject: OYSTER CREEK GENERATING STATION
DOCKET NO. 50-219
ANNUAL SEA TURTLE INCIDENTAL CAPTURE REPORT - 2002

Enclosed is a copy of the 2002 Annual Sea Turtle Incidental Capture Report for the Oyster Creek Generating Station (OCGS). The report is submitted in accordance with Condition 10 of the Incidental Take Statement of the OCGS Endangered Species Act Biological Opinion.

If you have any questions concerning this submittal, please contact Mr. John Rogers, Licensing Engineer at 609-971-4893 or Mr. Malcolm Browne, Environmental Scientist, at 609-971-4124.

Sincerely,

Ernest J. Harkness P.E., Vice President
Oyster Creek Generating Station

EJH/MEB/JJR
Enclosure
Attachments

FILE

cc: NRC Document Control Desk
Administrator, Region I
NRC Project Manager
Senior Resident Inspector

OYSTER CREEK GENERATING STATION

LICENSE NO. DPR-16
DOCKET NO. 50-219

ANNUAL REPORT OF SEA TURTLE INCIDENTAL CAPTURES 2002

Prepared by:

AMERGEN ENERGY COMPANY

December 2002

The Annual Report of Sea Turtle Incidental Captures provides a summary of the incidental captures of all species of sea turtles at the Oyster Creek Generating Station (OCGS) during the past year. The report is required by Condition 10 of the Incidental Take Statement of the OCGS Endangered Species Act, Section 7 Consultation, Biological Opinion. This report covers all incidental captures which occurred during the year 2002.

Incidental Capture Reports documenting the circumstances of incidental captures of sea turtles are completed following any OCGS sea turtle incidental capture and are provided to NMFS and USNRC. Incident reports concerning the capture of endangered sea turtles entitled "Sea Turtle Incidental Capture Report 2002-1" and "2002-2" are provided as Attachments I and II, respectively. The circumstances surrounding the two incidental captures that occurred during 2002 are summarized below. In all cases the incidental captures were reported to the Nuclear Regulatory Commission and the National Marine Fisheries Service within 24 hours of capture. Inspections and cleaning of cooling water intake trash bars continue to be conducted in accordance with Conditions 1 and 4 of the Incidental Take Statement.

Annual Summary of Sea Turtle Incidental Takes

A juvenile Kemp's ridley sea turtle was captured alive in front of the circulating water system trash racks during the morning of June 29, 2002 after it was observed swimming in front of the circulating water intake structure trash bars. NRC and NMFS were notified within 24 hours of the capture and the turtle was taken to the Marine Mammal Stranding Center (MMSC) in Brigantine, NJ by OCGS Environmental personnel. MMSC personnel observed and fed the turtle and found it to be active. A scar of unknown origin was observed on the right side of the carapace but determined not to be a significant concern by MMSC personnel because the turtle was initially eating on its own and appeared healthy. The turtle subsequently died while in MMSC care and a necropsy was performed.

During the morning of July 3, 2002, a juvenile Kemp's ridley sea turtle was gently removed from in front of the dilution water system intake structure. The turtle was alive and apparently healthy at the time of capture. Although there were no obvious boat propeller wounds on the turtle or any open wounds which would have been life-threatening, the turtle had a small scrape on one of its dorsal scutes. Environmental personnel transported the turtle to MMSC the same morning and held there for care, feeding, and observation. The turtle was subsequently tagged and released July 9, 2002 near Brigantine, NJ by MMSC personnel.

Regarding trends in the number of incidental sea turtle captures at the OCGS, two incidental captures occurred during 2002 which is slightly less than the longterm average of slightly over two incidental captures per year recorded over the last decade. The annual total of two incidental captures during 2002 is a reduction from the total of three sea turtles incidentally captured at OCGS during 2001. However, the annual abundance of sea turtles in this vicinity appears to be highly variable, unpredictable, and unrelated to the operation of the OCGS. There are several factors that may influence the number of sea turtle incidental captures which occur at the OCGS. Barnegat Inlet, the only tidal inlet in the vicinity of Oyster Creek, which provides access to Barnegat Bay from the Atlantic Ocean, was deepened during dredging operations in the early 1990's. Completion of the Barnegat Inlet dredging operation resulted in an increase in the tidal prism, or volume of water entering and exiting the inlet on a single tidal cycle, as well as a slightly greater tidal range at Oyster Creek. The deepening of Barnegat Inlet and associated waterway channels was completed immediately prior to 1992, when incidental captures of sea turtles began to occur at OCGS, and may partially explain the occurrence of the turtles.

It is likely that the local variability of sea turtle abundance is also related to biological factors including the abundance of organisms on which sea turtles prefer to feed, such as blue crabs, horseshoe crabs, and calico crabs. Physical factors, such as an oceanic front or an oceanic gyre occurring unusually close to Barnegat Inlet, may also play a part in the prevalence of sea turtles near Oyster Creek because oceanic fronts have been shown to be used as a migratory and forage habitat by sea turtles (Polovina et al, 2000).

Experience has also shown that the passage of a severe storm or pressure system near Barnegat Inlet can cause major increases in winds, waves, tides and tidal prism in shallow estuarine waters such as Barnegat Bay. These events could increase the likelihood of slowly swimming organisms such as sea turtles occurring in the estuary.

Many years of environmental sampling conducted near the OCGS have repeatedly demonstrated that the abundance of various marine organisms can vary considerably from year to year, often by orders of magnitude. This is particularly true for seasonal migrants, whose abundance in Barnegat Bay is highly dependent upon physical and biological factors along the migratory route. Therefore, the observed annual variation in sea turtle incidental captures at the OCGS from a minimum of zero to a maximum of five per year is not considered particularly significant. The ultimate goal of the considerable effort being put forward at the OCGS for the protection of sea turtles is to protect the turtles that do arrive at the plant, and to release as many turtles as possible to safety. The OCGS program for the protection of threatened and endangered sea turtles can be considered to be quite successful because most of the sea turtles incidentally captured at OCGS since 1992 have subsequently been released alive and well, to the Atlantic Ocean in locations free from potential cold-shock, due to the efforts of OCGS personnel.

References

Polovina, J.J., D.R. Kobayashi, D.M. Ellis, M.P. Seki, and G.H. Balazs. 2000. Turtles on the edge: Movement of loggerhead turtles (Caretta caretta) along oceanic fronts in the central North Pacific, 1997-1998. Fish. Oceanogr., 9: 71-82.

ATTACHMENT I

SEA TURTLE INCIDENTAL CAPTURE REPORT 2002-1

AmerGen

An Exelon/British Energy Company

AmerGen Energy Company, LLC
Oyster Creek
US Route 9 South
P.O. Box 388
Forked River, NJ 08731-0388

July 2, 2002
Correspondence No. 2002-0188
File No. 02051

US Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

Subject: Oyster Creek Generating Station
Docket 50-219
Sea Turtle Incidental Capture Report 2002-1

This report provides detailed information regarding the recent incidental capture of a juvenile Kemp's ridley sea turtle at the Oyster Creek Generating Station. The turtle was captured alive during the morning of June 29, 2002, after it was observed swimming in front of the circulating water intake structure trash bars. As indicated on the attached incident report, the turtle was taken to the Marine Mammal Stranding Center in Brigantine, NJ for examination, care, and eventual safe release.

If you have any questions or require additional information, please do not hesitate to contact Mr. Jay Vouglitois at (609) 971-4021.

Very truly yours,

for C.P. 7/2/02

Ron J. DeGregorio
Vice President, Oyster Creek

RJD/JJV/JJR
Enclosure
cc: Ms. Carrie McDaniel
U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Marine Fisheries Service Northeast Region
Protected Resources Division
One Blackburn Drive
Gloucester, MA 01930

cc: Mr. Hubert Miller, Administrator, Region 1
US Nuclear Regulatory Commission
475 Allendale Road
King of Prussia, PA 19406

Mr. Peter Tam
US Nuclear Regulatory Commission
Senior Project Manager
Washington, DC 20555

Mr. James Wilson, Mailstop O-11-F1
US Nuclear Regulatory Commission
Washington, DC 20555

Senior Resident Inspector
Oyster Creek Generating Station
PO Box 388
Forked River NJ 08731

Mr. Dave Jenkins
NJ Department of Environmental Protection
Division of Fish, Game, and Wildlife
P.O. Box 400
Trenton, NJ 08625-0400

OYSTER CREEK GENERATING STATION

Sea Turtle Incidental Capture Report 2002-1

At approximately 0200 hours on Saturday June 29, 2002, an Oyster Creek Generating Station (OCGS) operator performing a routine inspection of the trash racks noticed a sea turtle swimming freely in Bay #5 and Bay #6 of the circulating water intake structure. The turtle was carefully dip-netted from Bay #6 as quickly as possible and found to be apparently healthy and moving about normally. OCGS Environmental personnel who took custody of the turtle confirmed it to be a juvenile Kemp's ridley sea turtle (Lepidochelys kempi). The water temperature at the time of the incidental capture was approximately 79.2 F (26.2 C) and OCGS was in operation at full power with four circulating water pumps and two dilution pumps in operation. Although it is impossible to say precisely how long the turtle had been in the vicinity of the intake structure, the circulating water trash racks had been cleaned approximately four hours prior to the turtle's capture, at 2200 hours on June 28. The turtle was not observed during that trash rack cleaning process.

The turtle measured 10.0 in (25.4 cm) carapace length straight line and 9.5 in (24.1 cm) carapace width straight line. Sex was not determined. A scar was observed on the right side of the carapace; no tags were observed on the animal. USNRC and NMFS personnel were notified of the capture within 24 hours on June 29, 2002.

The turtle was taken to the Marine Mammal Stranding Center (MMSC) in Brigantine, NJ at approximately 0455 hours on June 29. At the MMSC, the turtle was examined and fed. The wound on the carapace was determined not to be a significant concern. The turtle will be held at the MMSC for a few days before it is tagged and released into near-shore waters around Brigantine, NJ.

SEA TURTLE STRANDING AND SALVAGE NETWORK - STRANDING REPORT

PLEASE PRINT CLEARLY AND FILL IN ALL APPLICABLE BLANKS. Use codes below. Measurements may be straight line (caliper) and/or over the curve (tape measure). Measure length from the center of the nuchal notch to the tip of the most posterior marginal. Measure width at the widest point of carapace. CIRCLE THE UNITS USED. See diagram below. Please give a specific location description. INCLUDE LATITUDE AND LONGITUDE.

Observer's Full Name: MARINE MAMMAL STRANDING CENTER
Stranding Date: 02 - 06 - 29 (year - month - day)

Address / Affiliation: Brigantine, N.J.

Area Code / Phone Number: 609-266-0538

Species: LK
Turtle Number By Day: 02-055

Reliability of I.D.: (CIRCLE) Unsure Probable **(Positive)**
Species Verified by State Coordinator? Yes ☒ No ☐

Sex: (CIRCLE) **(Female)** Male Undetermined
How was sex determined? necropsy

State: NEW JERSEY
County: Ocean

Location (be specific and include closest town): Forked River, on the intake pipe at Oyster Creek Nuclear Power Plant

Latitude: 39° 48'56.3"N
Longitude: 74° 12'25.8"W

Condition of Turtle (use codes): 0
Final Disposition of Turtle (use codes): 7

Tag Number(s) (include tag return address and disposition of tag):

Remarks (note if turtle was involved with tar or oil, gear or debris entanglement, wounds or mutilations, propellor damage, papillomas, epizoa, etc.) continue on back if necessary

Turtle had a crack on the dorsal right side of its carapace. It was eatigg on its won, and appeared to be swimming weel. It was found dead in theppen, and necropsy was performed (over) Field # 02-055

MEASUREMENTS: CIRCLE UNITS

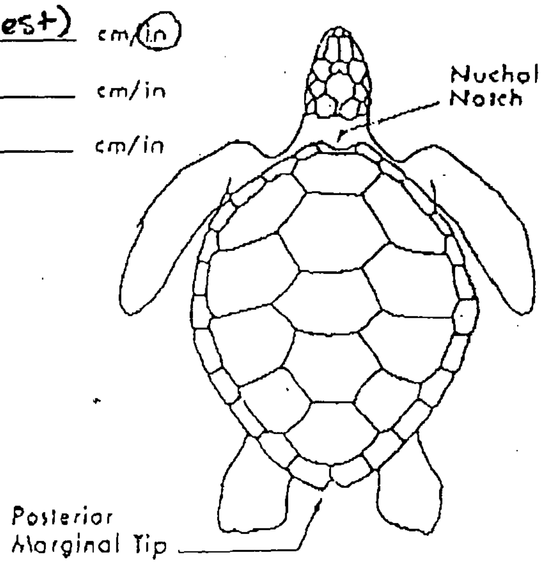
Straight Length: 10.5 (est) cm/**(in)**

Straight Width: 9.75 (est) cm/**(in)**

Curved Length: ______ cm/in

Curved Width: ______ cm/in

Mark wounds, abnormalities, and tag locations



CODES:

SPECIES:
- CC = Loggerhead
- CM = Green
- DC = Leatherback
- EI = Hawksbill
- LK = Kemp's ridley
- UN = Unidentified

CONDITION OF TURTLE:
- 0 = Alive
- 1 = Fresh dead
- 2 = Moderately decomposed
- 3 = Severely decomposed
- 4 = Dried carcass
- 5 = Skeleton, bones only

FINAL DISPOSITION OF TURTLE:
- 1 = Painted, left on beach
- 2 = Buried: on beach / off beach
- 3 = Salvaged specimen: all / part
- 4 = Pulled up on beach or dune
- 5 = Unpainted, left on beach
- 6 = Alive, released
- 7 = Alive, taken to a holding facility

All tissues surrounding the cracked area were necrotic.

ATTACHMENT II

SEA TURTLE INCIDENTAL CAPTURE REPORT
2002-2

AmerGen

AmerGen Energy Company, LLC
Oyster Creek
US Route 9 South
P.O. Box 388
Forked River, NJ 08731-0388

An Exelon/British Energy Company

July 8, 2002
2130-02-20189

US Nuclear Regulatory Commission
Document Control Desk - NRC
Washington, DC 20555

Subject: Oyster Creek Generating Station
Docket 50-219
Sea Turtle Incidental Capture Report 2002-2

This report provides detailed information regarding the recent incidental capture of a juvenile Kemp's ridley sea turtle at the Oyster Creek Generating Station. The turtle was captured alive during the morning of July 3, 2002 after it was observed swimming in front of the dilution water intake structure trash bars. As indicated on the attached incident report, the turtle was taken to the Marine Mammal Stranding Center in Brigantine, New Jersey for examination, care, and eventual safe release.

If you have any questions or require additional information, please do not hesitate to contact Mr. Malcolm Browne at (609) 971-4124.

Very truly yours,

E. Hall for R.D. 7/8/02

Ron J. DeGregorio
Vice President, Oyster Creek

RJD/MEB/JJR
Enclosure

cc: Ms. Carrie McDaniel
U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Marine Fisheries Service Northeast Region
Protected Resources Division
One Blackburn Drive
Gloucester, MA 01930

cc: Mr. Hubert Miller,Administrator, Region 1
US Nuclear Regulatory Commission
475 Allendale Road
King of Prussia, PA 19406

Mr. Peter Tam
US Nuclear Regulatory Commission
Senior Project Manager
Washington, DC 20555

Mr. James Wilson, Mailstop O-11-F1
US Nuclear Regulatory Commission
Washington, DC 20555

Senior Resident Inspector
Oyster Creek Generating Station
PO Box 388
Forked River, NJ 08731

Mr. Dave Jenkins
NJ Department of Environmental Protection
Division of Fish, Game, and Wildlife
P.O. Box 400
Trenton , NJ 08625-0400

OYSTER CREEK GENERATING STATION

Sea Turtle Incidental Capture Report 2002-2

At approximately 0755 hours on Wednesday July 3, 2002, an Oyster Creek Generating Station (OCGS) operator performing a routine inspection of the trash racks noticed a sea turtle swimming freely in Bay # 5 of the dilution water intake structure. The turtle was carefully dip-netted from Bay #5 as quickly as possible and found to be apparently healthy and moving about normally. OCGS Environmental personnel who took custody of the turtle confirmed it to be a juvenile Kemp's ridley sea turtle (Lepidochelys kempi). The water temperature at the time of the incidental capture was approximately 82.8 °F (28.2 °C) and OCGS was in operation at 100% power with four circulating water pumps and two dilution pumps in operation. Although it is impossible to say precisely how long the turtle had been on the trash bars prior to removal, the dilution water trash racks had been cleaned earlier the same day at 0500 hours. The turtle was not observed during that trash rack inspection and cleaning.

The turtle measured 14.0 in (35.6 cm) carapace length straight line and weighed 13.3 lb (6.0 kg). Sex was not determined. A small scrape less than 1 cm long was observed on one of the dorsal scutes of the carapace. No tags were present on the turtle when captured. USNRC and NMFS personnel were notified of the capture within 24 hours on July 3, 2002.

The turtle was taken to the Marine Mammal Stranding Center (MMSC) in Brigantine, NJ at approximately 1015 hours on July 3. At the MMSC, the turtle was examined and fed. The scrape on the carapace was determined not to be a significant concern. The turtle will held at the MMSC for a few days before it is tagged and released into near-shore waters around Brigantine, NJ.

SEA TURTLE STRANDING AND SALVAGE NETWORK - STRANDING REPORT

PLEASE PRINT CLEARLY AND FILL IN ALL APPLICABLE BLANKS. Use codes below. Measurements may be straight line (caliper) and/or over the curve (tape measure). Measure length from the center of the nuchal notch to the tip of the most posterior marginal. Measure width at the widest point of carapace. CIRCLE THE UNITS USED. See diagram below. Please give a specific location description. INCLUDE LATITUDE AND LONGITUDE.

Observer's Full Name: MARINE MAMMAL STRANDING CENTER   Stranding Date: 02 - 07 - 03 (year, month, day)

Address / Affiliation: Brigantine, N.J.

Area Code / Phone Number: 609-266-0538

Species: LK   Turtle Number By Day: 02-057

Reliability of I.D.: (CIRCLE) Unsure Probable **(Positive)**   Species Verified by State Coordinator? Yes ☒ No ☐

Sex: (CIRCLE) **(Female)** Male Undetermined   How was sex determined? tail length

State: NEW JERSEY   County: Ocean

Location (be specific and include closest town): Forked River, on the intake of dilution trash racks at Oyster Creek Power Plant

Latitude: 39° 48'56.3"N   Longitude: 74° 12'25.8"W

Condition of Turtle (use codes): 0   Final Disposition of Turtle (use codes): 7

Tag Number(s) (include tag return address and disposition of tag):

Remarks (note if turtle was involved with tar or oil, gear or debris entanglement, wounds or mutilations, propellor damage, papillomas, epizoa, etc.) continue on back if necessary

Slight knock on left side of carapace near head. Active and alert. Swimming and eating well. Tagged monel ear tag #SSL127 right front flipper and released on 9 July 2002 in Brigantine, NJ Field # 02-057

MEASUREMENTS: CIRCLE UNITS

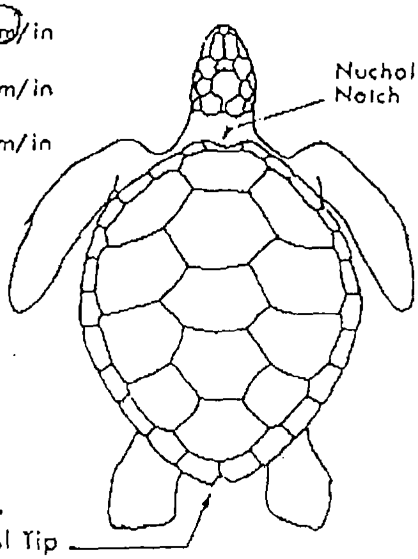
Straight Length: 34 (cm)/in

Straight Width: 32.5 (cm)/in

Curved Length: ______ cm/in

Curved Width: ______ cm/in

Mark wounds, abnormalities, and tag locations



CODES:

SPECIES:
- CC = Loggerhead
- CM = Green
- DC = Leatherback
- EI = Hawksbill
- LK = Kemp's ridley
- UN = Unidentified

CONDITION OF TURTLE:
- 0 = Alive
- 1 = Fresh dead
- 2 = Moderately decomposed
- 3 = Severely decomposed
- 4 = Dried carcass
- 5 = Skeleton, bones only

FINAL DISPOSITION OF TURTLE:
- 1 = Painted, left on beach
- 2 = Buried: on beach / off beach
- 3 = Salvaged specimen: all / part
- 4 = Pulled up on beach or dune
- 5 = Unpainted, left on beach
- 6 = Alive, released
- 7 = Alive, taken to a holding facility

December 30, 2003

2130-03-20319
2120-032-2798

National Marine Fisheries Service Northeast Region
Protected Resources Division
One Blackburn Drive
Gloucester, MA 01930
Attention: Carrie Udite

Dear Ms. Udite:

Subject: OYSTER CREEK GENERATING STATION (OCGS)
DOCKET NO. 50-219
ANNUAL SEA TURTLE INCIDENTAL CAPTURE REPORT - 2003

Enclosed is a copy of the 2003 Annual Sea Turtle Incidental Capture Report for the Oyster Creek Generating Station. The report is submitted in accordance with Condition 10 of the Incidental Take Statement of the OCGS Endangered Species Act Biological Opinion.

If you have any questions concerning this submittal, please contact Mr. William Stewart, Licensing Engineer at 609-971-4775 or Mr. Malcolm Browne, Environmental Scientist, at 609-971-4124.

Sincerely,

Michael J. Massaro for E. Harkness

Ernest J. Harkness
Vice President
Oyster Creek

EJH/WS

Enclosure

cc: NRC Document Control Desk
Administrator, Region I
NRC Project Manager
Senior Resident Inspector

ANNUAL REPORT OF SEA TURTLE INCIDENTAL CAPTURES - 2003

OYSTER CREEK GENERATING STATION

LICENSE NO. DPR-16

DOCKET NO. 50-219

Prepared by:

AMERGEN ENERGY COMPANY

December 2003

Introduction

The Annual Report of Sea Turtle Incidental Captures provides a summary of the incidental captures of all species of sea turtles at the Oyster Creek Generating Station (OCGS) during the past year. The report is required by Condition 10 of the Incidental Take Statement of the OCGS Endangered Species Act, Section 7 Consultation, Biological Opinion. This report covers all incidental captures which occurred during 2003.

Incidental Capture Reports documenting the circumstances of incidental captures of sea turtles are completed following any OCGS sea turtle incidental capture and are provided to NMFS and USNRC. Incident reports concerning the capture of endangered sea turtles entitled "Sea Turtle Incidental Capture Report 2003-1 and 2003-2" are provided as Attachments I and II, respectively. The circumstances surrounding the two incidental captures that occurred during 2003 are summarized below. In all cases the incidental captures were reported to the Nuclear Regulatory Commission and the National Marine Fisheries Service within 24 hours of capture. Inspections and cleaning of cooling water intake trash bars continue to be conducted in accordance with Conditions 1 and 4 of the Incidental Take Statement.

Annual Summary of Sea Turtle Incidental Takes

A juvenile Kemp's ridley sea turtle was captured alive after being gently removed from the dilution water system trash racks during the afternoon of September 24, 2003. NRC and NMFS were notified within 24 hours of the capture and the turtle was taken to the Marine Mammal Stranding Center (MMSC) in Brigantine, NJ by OCGS Environmental personnel. MMSC personnel observed and fed the turtle and found it to be active. Small scrapes of unknown origin were observed on the dorsal and ventral sides of the carapace but determined not to be a significant concern by MMSC personnel because the turtle was initially eating on its own and appeared healthy. The turtle was held at MMSC for less than a day before it was tagged and released into near-shore waters near Brigantine, NJ.

During the morning of October 24, 2003, a juvenile green sea turtle was gently removed from in front of the circulating water system intake structure. The turtle was alive and apparently healthy at the time of capture. Although there were no obvious boat propeller wounds on the turtle or any open wounds which would have been life-threatening, the turtle had small scrapes on its dorsal and lateral portions of its carapace. Environmental personnel transported the turtle to MMSC the same morning and held there for care, feeding, and observation. The turtle was held at the MMSC until arrangements were made to transfer it to the Virginia Marine Science Museum (VMSM). VMSM is a more southerly location where the turtle could be observed, fed, and eventually released without fear of it dying due to cold shock.

Regarding trends in the number of incidental sea turtle captures at the OCGS, two incidental captures occurred during 2003 which is slightly less than the longterm average of slightly over two incidental captures per year recorded over the last decade. The annual total of two incidental captures during 2003 is the same as the total of two sea turtles incidentally captured at OCGS during 2002. However, the annual abundance of sea turtles in this vicinity appears to be highly variable, unpredictable, and unrelated to the operation of the OCGS. There are several factors that may influence the number of sea turtle incidental captures which occur at the OCGS. Barnegat Inlet, the only tidal inlet in the vicinity of Oyster Creek, which provides access to Barnegat Bay from the Atlantic Ocean, was deepened during dredging operations in the early 1990's. Completion of the Barnegat Inlet dredging operation resulted in an increase in the tidal prism, or volume of water entering and exiting the inlet on a single tidal cycle, as well as a slightly greater tidal range at Oyster Creek. The deepening of Barnegat Inlet and associated waterway channels was completed immediately prior to 1992, when incidental captures of sea turtles began to occur at OCGS, and may partially explain the occurrence of the turtles.

It is likely that the local variability of sea turtle abundance is also related to biological factors including the abundance of organisms on which sea turtles prefer to feed, such as blue crabs, horseshoe crabs, and calico crabs. Physical factors, such as an oceanic front or an oceanic gyre occurring unusually close to Barnegat Inlet, may also play a part in the prevalence of sea turtles near Oyster Creek because oceanic fronts have been shown to be used as a migratory and forage habitat by sea turtles (Polovina et al, 2000). Experience has also shown that the passage of a severe storm or pressure system near Barnegat Inlet can cause major increases in winds, waves,

tides and tidal prism in shallow estuarine waters such as Barnegat Bay. These events could increase the likelihood of slowly swimming organisms such as sea turtles occurring in the estuary.

Many years of environmental sampling conducted near the OCGS have repeatedly demonstrated that the abundance of various marine organisms can vary considerably from year to year, often by orders of magnitude. This is particularly true for seasonal migrants, whose abundance in Barnegat Bay is highly dependent upon physical and biological factors along the migratory route. Therefore, the observed annual variation in sea turtle incidental captures at the OCGS from a minimum of zero to a maximum of five per year is not considered particularly significant. The ultimate goal of the considerable effort being put forward at the OCGS for the protection of sea turtles is to protect the turtles that do arrive at the plant, and to release as many turtles as possible to safety. The OCGS program for the protection of threatened and endangered sea turtles can be considered to be quite successful because most of the sea turtles incidentally captured at OCGS since 1992 have subsequently been released alive and well, to the Atlantic Ocean in locations free from potential cold-shock, due to the efforts of OCGS personnel.

References

Polovina, J.J., D.R. Kobayashi, D.M. Ellis, M.P. Seki, and G.H. Balazs. 2000. Turtles on the edge: Movement of loggerhead turtles (Caretta caretta) along oceanic fronts in the central North Pacific, 1997-1998. Fish. Oceanogr., 9: 71-82.

ATTACHMENT I

SEA TURTLE INCIDENTAL CAPTURE REPORT 2003-1

OYSTER CREEK GENERATING STATION

Sea Turtle Incidental Capture Report 2003-1

At approximately 1455 hours on Wednesday September 24, 2003, an Oyster Creek Generating Station (OCGS) operator performing a routine cleaning of the trash racks noticed a sea turtle among the vegetation and debris removed from Bay # 6 of the dilution water intake structure. The turtle was found to be apparently healthy and moving about normally. OCGS Environmental personnel who took custody of the turtle confirmed it to be a juvenile Kemp's ridley sea turtle (Lepidochelys kempi). The water temperature at the time of the incidental capture was approximately 73 F (22.8 C) and OCGS was in operation at 100% power with four circulating water pumps and two dilution pumps in operation. Although it is impossible to say precisely how long the turtle had been on the trash bars prior to removal, the dilution water trash racks had been cleaned earlier the prior day at 1345 hours. The turtle was not observed during that trash rack inspection and cleaning.

The turtle measured 12.2 in (31.1 cm) carapace length straight line and weighed 11.5 lb (5.2 kg). Sex was not determined. Some small scrapes were observed on the dorsal and ventral surfaces of the carapace. No tags were present on the turtle when captured. USNRC and NMFS personnel were notified of the capture within 24 hours on September 24, 2003.

The turtle was taken to the Marine Mammal Stranding Center (MMSC) in Brigantine, NJ at approximately 1745 hours on September 24, 2003. At the MMSC, the turtle was examined and fed. The scrapes on the carapace were determined not to be a significant concern. The turtle was held at the MMSC for less than a day before it was tagged and released into near-shore Atlantic Ocean waters around Brigantine, NJ.

ATTACHMENT II

SEA TURTLE INCIDENTAL CAPTURE REPORT 2003-2

OYSTER CREEK GENERATING STATION

Sea Turtle Incidental Capture Report 2003-2

At approximately 0850 hours on Friday October 24, 2003, an Oyster Creek Generating Station (OCGS) operator performing a routine cleaning of the trash racks noticed a sea turtle against Bay # 4 of the circulating water intake structure. The turtle was found to be apparently healthy and moving about normally. OCGS Environmental personnel who took custody of the turtle confirmed it to be a juvenile green sea turtle (Chelonia mydas). The water temperature at the time of the incidental capture was approximately 53 F (11.7 C) and OCGS was in operation at 98% power with three circulating water pumps and two dilution pumps in operation. Although it is impossible to say precisely how long the turtle had been on the trash bars prior to removal, the circulating water trash racks had been inspected earlier the same morning at 0500 hours. The turtle was not observed during that trash rack inspection.

The turtle measured 14.2 in (36.2 cm) carapace length straight line and weighed 15.3 lb (6.9 kg). Sex was not determined. Some small scrapes and chips were observed on the dorsal and lateral surfaces of the carapace. No tags were present on the turtle when captured. USNRC and NMFS personnel were notified of the capture within 24 hours on October 24, 2003.

The turtle was taken to the Marine Mammal Stranding Center (MMSC) in Brigantine, NJ at approximately 1030 hours on October 24, 2003. At the MMSC, the turtle was examined and fed. The scrapes on the carapace were determined not to be a significant concern. The turtle was held at the MMSC until arrangements were made to transfer it to the Virginia Marine Science Museum (VMSM). VMSM is a more southerly location where the turtle could be observed, fed, and eventually released without fear of it dying due to cold shock.

AmerGen
AmerGen Energy Company, LLC
Oyster Creek
US Route 9 South, P.O. Box 388
Forked River, NJ 08731-0388
www.exeloncorp.com
An Exelon Company

2130-04-20334
2120-042-2872

National Marine Fisheries Service Northeast Region
Protected Resources Division
One Blackburn Drive
Gloucester, MA 01930
Attention: Pasquale Scida

Dear Mr. Scida:

Subject: OYSTER CREEK GENERATING STATION (OCGS)
DOCKET NO. 50-219
ANNUAL SEA TURTLE INCIDENTAL CAPTURE REPORT - 2004

Enclosed is a copy of the 2004 Annual Sea Turtle Incidental Capture Report for the Oyster Creek Generating Station. The report is submitted in accordance with Condition 10 of the Incidental Take Statement of the OCGS Endangered Species Act Biological Opinion.

If you have any questions concerning this submittal, please contact Mr. David Fawcett, Licensing Engineer at 609-971-4284 or Mr. Malcolm Browne, Environmental Specialist, at 609-971-4124.

Sincerely,

C. N. Swenson
Vice President, Oyster Creek Generating Station

CNS/MEB/dif

Enclosure: Annual Sea Turtle Report Incidental Captures - 2004

cc: NRC Document Control Desk
Samuel J. Collins, Administrator, Region 1
Peter Tam, NRC Project Manager
Robert Summers, Senior Resident Inspector

ANNUAL REPORT OF SEA TURTLE INCIDENTAL CAPTURES - 2004

OYSTER CREEK GENERATING STATION

LICENSE NO. DPR-16

DOCKET NO. 50-219

Prepared by:

AMERGEN ENERGY COMPANY

December 2004

Introduction

The Annual Report of Sea Turtle Incidental Captures provides a summary of the incidental captures of all species of sea turtles at the Oyster Creek Generating Station (OCGS) during the past year. The report is required by Condition 10 of the Incidental Take Statement of the OCGS Endangered Species Act, Section 7 Consultation, Biological Opinion. This report covers all incidental captures which occurred during 2004.

Incidental Capture Reports documenting the circumstances of incidental captures of sea turtles are completed following any OCGS sea turtle incidental capture and are provided to NMFS and USNRC. A complete summary of the incident reports concerning the capture of endangered sea turtles entitled "Sea Turtle Incidental Capture Report 2004-1 through 2004-8" is provided herein. The circumstances surrounding the incidental captures that occurred during 2004 are described below. In all cases the incidental captures were reported to the Nuclear Regulatory Commission and the National Marine Fisheries Service within 24 hours of capture. Inspections and cleaning of cooling water intake trash bars continue to be conducted in accordance with Conditions 1 and 4 of the Incidental Take Statement.

Annual Summary of Sea Turtle Incidental Takes – 2004

Incidental Capture Report 2004-1 - **July 4, 2004**

At approximately 12:15 PM on Sunday July 4, 2004, an OCGS Operator performing a routine cleaning of the trash racks noticed a sea turtle among the vegetation and debris removed from Bay # 4 of the dilution water intake structure. The turtle appeared to be either comatose or dead. In accordance with OCGS procedures, Operators initiated resuscitation of the sea turtle but were unable to revive it. OCGS Environmental personnel who took custody of the turtle confirmed it to be a juvenile Kemp's ridley sea turtle. The water temperature at the time of the incidental capture was approximately 25.6°C (78.1°F) and the OCGS was operating at 100 percent power with four circulating water pumps and two dilution pumps in operation. Although it is impossible to say precisely how long the turtle had been on the trash bars prior to removal, the dilution water trash racks had been inspected earlier the same day at 8:00 AM. The turtle was not observed during that trash rack inspection.

The turtle measured 26.5 cm (10.4 in) carapace length straight line and weighed 5.4 kg (11.9 lb). Some small scrapes were observed on the ventral surface of the carapace. It was not possible to determine definitively whether the turtle had died prior to arriving at OCGS or as a result of interaction with the OCGS intake. No tags were present on the turtle when captured.

The turtle was taken to the MMSC in Brigantine, NJ at approximately 3:00 PM on July 4, 2004. At the MMSC, the turtle was examined, measured and a necropsy was performed. MMSC personnel indicated that the necropsy indicated that the lungs were compressed, but that the cause of death was indeterminate. The turtle was buried by MMSC personnel at Brigantine, NJ.

Incidental Capture Report 2004-2 - **July 11, 2004**

At approximately 2:22 PM on Sunday July 11, 2004, an OCGS operator preparing to perform a routine cleaning of the trash racks noticed a sea turtle swimming in the water immediately upstream of the trash racks in Bay # 5 of the dilution water intake structure. The turtle appeared briefly at the water surface before diving out of sight. In accordance with OCGS procedures, operators immediately initiated efforts to retrieve the turtle as rapidly and gently as possible. OCGS Environmental personnel who took custody of the turtle confirmed it to be a juvenile Kemp's ridley sea turtle. The water temperature at the time of the incidental capture was approximately 27.5°C (81.5°F) and OCGS was operating at 100 percent power with four circulating water pumps and two dilution pumps in operation. Although it is impossible to say precisely how long the turtle had been swimming in the area of the trash bars prior to removal, the dilution water trash racks had been inspected earlier the same day at 1:15 PM. The turtle was not observed during that trash rack inspection.

The turtle measured 22.3 cm (8.8 in) carapace length straight line and weighed 1.8 kg (4.0 lb). Some very minor scrapes were observed on the ventral surface of the carapace. No external tags were present on the turtle when captured.

The turtle was taken to the MMSC in Brigantine, NJ at approximately 4:23 PM on July 11, 2004. At the MMSC, the turtle was examined and held to ensure it was feeding well. The turtle was released two days later to a safe location off of Brigantine, NJ.

Incidental Capture Report 2004-3 - **July 16, 2004**

At approximately 11:00 AM on Friday July 16, 2004, an OCGS Operator performing a routine cleaning of the trash racks noticed a sea turtle among the vegetation and debris removed from Bay # 5 of the dilution water intake structure. The turtle appeared to be alive and in good condition when captured. OCGS Environmental personnel who took custody of the turtle confirmed it to be a juvenile Kemp's ridley sea turtle. The water temperature at the time of the incidental capture was approximately 24.4°C (76.0°F) and the OCGS was operating at 100 percent power with four circulating water pumps and two dilution pumps in operation. Although it is impossible to say precisely how long the turtle had been on the trash bars prior to removal, the dilution water trash racks had been inspected earlier the same day at 9:00 AM. The turtle was not observed during that trash rack inspection.

The turtle measured 28.0 cm (11.0 in) carapace length straight line and weighed 3.1 kg (6.9 lb). Some small scrapes were observed on the plastron (undersurface of the carapace). No tags were present on the turtle when captured.

The turtle was taken to the MMSC in Brigantine, NJ at approximately 1:00 PM on July 16, 2004. At the MMSC, the turtle was examined, fed and observed. The turtle was released by MMSC personnel to a safe location off Brigantine, NJ.

Incidental Capture Report 2004-4 - **July 20, 2004**

At approximately 12:13 PM on Tuesday July 20, 2004, an OCGS Operator performing a routine cleaning of the trash racks noticed a sea turtle among the vegetation and debris removed from Bay # 1 of the circulating water intake structure. The turtle appeared to be either comatose or dead. In accordance with OCGS procedures, Operators initiated resuscitation of the sea turtle but were unable to revive it. OCGS Environmental personnel who took custody of the turtle confirmed it to be a juvenile Kemp's ridley sea turtle. The water temperature at the time of the incidental capture was approximately 26.5°C (79.7°F) and the OCGS was operating at 100 percent power with four circulating water pumps and two dilution pumps in operation. Although it is impossible to say precisely how long the turtle had been on the trash bars prior to removal, the circulating water trash racks had been inspected at 9:15 PM the previous evening. The turtle was not observed during that trash rack inspection.

The turtle measured only 18.3 cm (7.2 in) carapace length straight line and weighed just 0.8 kg (1.8 lb). A small puncture wound about 1.3 cm (0.5 in) in diameter was observed on the left rear surface of the carapace. It was not possible to determine definitively whether the turtle had died prior to arriving at OCGS or as a result of interaction with the OCGS intake. No tags were present on the turtle when captured.

The turtle was taken to the MMSC in Brigantine, NJ at approximately 10:00 AM on July 21, 2004. At the MMSC, the turtle was examined, measured and a necropsy was performed. MMSC personnel included the results of the necropsy on the STSSN form and the turtle was buried by MMSC personnel at Brigantine, NJ.

Incidental Capture Report 2004-5 – **August 7, 2004**

At approximately 9:00 AM on Saturday August 7, 2004, an OCGS Operator performing a routine cleaning of the trash racks noticed a sea turtle among the vegetation and debris removed from Bay #5 of the dilution water intake structure. The turtle appeared to be alive, healthy and moving about normally. OCGS personnel who took custody of the turtle confirmed it to be a juvenile Kemp's ridley sea turtle. The water temperature at the time of the incidental capture was approximately 22.7°C (72.8°F) and the OCGS was operating at 100 percent power with four circulating water pumps and two dilution pumps in operation. Although it is impossible to say precisely how long the turtle had been on the trash bars prior to removal, the dilution water trash racks had been inspected at 5:15 AM the same morning. The turtle was not observed during that trash rack inspection.

The turtle measured 27.0 cm (10.6 in) carapace length straight line and weighed 3.2 kg (7.0 lb). A small bruise on the plastron was noted. Also, a healed scar from a previous injury (i.e., not related to interaction with the OCGS) was noted on the left side of the turtle's head, immediately in front of its left eye. No tags were present on the turtle when captured.

The turtle was taken to the MMSC in Brigantine, NJ during the morning of August 7, 2004. At the MMSC, the turtle was examined, measured, observed, tagged and subsequently released to safety in the ocean off Brigantine, NJ.

Incidental Capture Report 2004-6 – **September 11, 2004**

At approximately 10:10 AM on Saturday September 11, 2004, an OCGS Operator performing a routine cleaning of the trash racks noticed a sea turtle among the vegetation and debris removed from Bay # 4 of the dilution water intake structure. The turtle appeared to be either comatose or dead. In accordance with OCGS procedures, Operators initiated resuscitation of the sea turtle but were unable to revive it. OCGS Environmental personnel who took custody of the turtle confirmed it to be a juvenile Kemp's ridley sea turtle. The water temperature at the time of the incidental capture was approximately 24.3°C (75.8°F) and the OCGS was operating at 100 percent power with four circulating water pumps and two dilution pumps in operation. Although it is impossible to say precisely how long the turtle had been on the trash bars prior to removal, the dilution water trash racks had been inspected and cleaned the previous morning. The turtle was not observed during that trash rack inspection and cleaning.

The turtle measured 22.3 cm (8.8 in) carapace length straight line and weighed 2.2 kg (4.8 lb). A small puncture wound was observed on the underside of the neck. No tags were present on the turtle when captured.

The turtle was taken to the MMSC in Brigantine, NJ at approximately 12:30 PM on September 11, 2004. At the MMSC, the turtle was examined and measured. The turtle was transferred to the New Bolton Center of the University of Pennsylvania School of Veterinary Medicine, where a necropsy was performed. It was not possible to determine definitively whether the turtle had died prior to arriving at OCGS or as a result of interaction with the OCGS intake.

Incidental Capture Report 2004-7 – **September 12, 2004**

At approximately 11:29 PM on Sunday September 12, 2004, an OCGS Operator performing a routine cleaning of the trash racks noticed a sea turtle among the vegetation and debris removed from Bay # 5 of the circulating water intake structure. The turtle appeared to be healthy, alert and moving about normally. OCGS Environmental personnel confirmed it to be a juvenile Kemp's ridley sea turtle. The water temperature at the time of the incidental capture was approximately 24.9°C (76.8°F) and the OCGS was operating at 40 percent power with four circulating water pumps and two dilution pumps in operation. Although it is impossible to say precisely how long the turtle had been on the trash bars prior to removal, the circulating water trash racks had been inspected at 8:00 PM the same evening. The turtle was not observed during that trash rack inspection.

The turtle measured 21.0 cm (8.3 in) carapace length straight line and weighed 1.4 kg (3.1 lb). The left front flipper was nearly entirely missing due to a previous injury that had completely healed. No tags or scarring from tags were present on the turtle when captured.

The turtle was taken to the MMSC in Brigantine, NJ at approximately 7:00 AM on September 13, 2004. At the MMSC, the turtle was examined, measured, fed and held for subsequent release. The turtle was transported to the Virginia Marine Science Museum during the week of September 27, 2004 for tagging and release to the Atlantic Ocean. The release of the turtle from a more southerly locale eliminated the possibility of autumn cold stunning effects that could have occurred if the turtle had been released from a New Jersey location at that time of year.

Incidental Capture Report 2004-8 – **September 23, 2004**

At approximately 9:45 PM on Thursday September 23, 2004, an OCGS operator performing a routine cleaning of the trash racks noticed a sea turtle among the vegetation and debris removed from Bay #3 of the circulating water intake structure. The turtle appeared to be alert and responsive. OCGS Environmental personnel who took custody of the turtle confirmed it to be a juvenile Kemp's ridley sea turtle. The water temperature at the time of the incidental capture was approximately 21.9°C (71.4°F) and OCGS was operating at 100 percent power with four circulating water pumps and two dilution pumps in operation. Although it is impossible to say precisely how long the turtle had been on the trash bars prior to removal, the circulating water trash racks had been inspected earlier the same day. The turtle was not observed during that trash rack inspection.

The turtle measured 24.2 cm (9.5 in) carapace length straight line and weighed 1.9 kg (4.2 lb). Small abrasions on the underside of the carapace of the turtle were observed. No tags or scarring from previous tags were present on the turtle when captured.

The turtle was taken to the MMSC in Brigantine, NJ at approximately 6:00 AM on September 24, 2004. At the MMSC, the turtle was examined, measured, fed and held for observation prior to release. The turtle was transported to the Virginia Marine Science Museum during the week of September 27, 2004 for tagging and release to the Atlantic Ocean. The release of the turtle from a more southerly locale eliminated the possibility of autumn cold stunning effects that could have occurred if the turtle had been released from a New Jersey location at that time of year.

Comparison of Annual Sea Turtle Incidental Takes With Prior Years

Regarding trends in the number of incidental sea turtle captures at the OCGS, eight incidental captures occurred during 2004 which is greater than the long term average of slightly over two incidental captures per year recorded over the last decade. However, the annual abundance of sea turtles in this vicinity appears to be highly variable, unpredictable, and unrelated to the operation of the OCGS. There are several factors that may influence the number of sea turtle incidental captures that occur at the OCGS. Barnegat Inlet, the only tidal inlet in the vicinity of Oyster Creek, which provides access to Barnegat Bay from the Atlantic Ocean, was deepened during dredging operations in the early 1990's. Completion of the Barnegat Inlet dredging operation resulted in an increase in the tidal prism, or volume of water entering and exiting the inlet on a single tidal cycle, as well as a slightly greater tidal range at Oyster Creek. The deepening of Barnegat Inlet and associated waterway channels was completed immediately prior to 1992, when incidental captures of sea turtles began to occur at OCGS, and may partially explain the occurrence of the turtles.

It is likely that the local variability of sea turtle abundance is also related to biological factors including the abundance of organisms on which sea turtles prefer to feed, such as blue crabs, horseshoe crabs, and calico crabs. Blue crabs have been particularly abundant in Barnegat Bay in recent years, in contrast to other coastal bays along the Atlantic coast such as Chesapeake Bay. Physical factors, such as an oceanic front or an oceanic gyre occurring unusually close to Barnegat Inlet, may also play a part in the prevalence of sea turtles near Oyster Creek because oceanic fronts have been shown to be used as a migratory and forage habitat by sea turtles (Polovina et al, 2000). Experience has also shown that the passage of a severe storm or pressure system near Barnegat Inlet can cause major increases in winds, waves, tides and tidal prism in shallow estuarine waters such as Barnegat Bay. These events could increase the likelihood of slowly swimming organisms such as sea turtles occurring in the estuary. During 2004, an unusually high number of hurricanes and major tropical storms occurred, which could have caused sea turtles to seek or remain within shallow estuarine areas such as Barnegat Bay for longer periods of time than normal.

Many years of environmental sampling conducted near the OCGS have repeatedly demonstrated that the abundance of various marine organisms can vary considerably from year to year, often by orders of magnitude. This is particularly true for seasonal migrants, whose abundance in Barnegat Bay is highly dependent upon physical and biological factors along the migratory route. The continuing trend of greatly increasing numbers of Kemp's ridley nesting females which has been documented in the scientific literature, as well as the possibility of corresponding significant increases in recruitment of Kemp's juveniles in recent years, are other factors which could have led to the higher than usual number of incidental captures at the OCGS Therefore, the observed annual variation in sea turtle incidental captures at the OCGS from a minimum of zero to a maximum of eight per year is not considered particularly significant. The ultimate goal of the considerable effort being put forward at the OCGS for the protection of sea turtles is to protect the turtles that do arrive at the plant, and to release as many turtles as possible to safety. The OCGS program for the protection of threatened and endangered sea turtles can be considered to be quite successful because most of the sea turtles incidentally captured at OCGS since 1992 have subsequently been released alive and well, to the Atlantic Ocean in locations free from potential cold-shock, due to the efforts of OCGS personnel.

Because the number of incidental captures of Kemp's ridley turtles during 2004 at the OCGS exceeded the Incidental Take Statement (ITS) limit, a request for reinitiation of formal Section 7 consultation was submitted to National Marine Fisheries Service (NMFS) during August 2004 (P.-T. Kuo, USNRC letter dtd 8/26/04 to P. A. Kurul, NMFS). Furthermore, an updated biological assessment which includes a detailed discussion of the incidental captures of sea turtles at the OCGS that have occurred since the current biological opinion was issued during July 2001 has been prepared for submittal to NMFS.

References

Polovina, J.J., D.R. Kobayashi, D.M. Ellis, M.P. Seki, and G.H. Balazs. 2000. Turtles on the edge: Movement of loggerhead turtles (Caretta caretta) along oceanic fronts in the central North Pacific, 1997-1998. Fish. Oceanogr., 9: 71-82.

Pao-Tsin Kuo, USNRC Docket No. 50-219 letter to Patricia A. Kurul, NMFS dated 8/26/04, entitled "Request for Reinitiation of Formal Section 7 Consultation under the Endangered Species Act regarding sea turtles at the Oyster Creek Nuclear Generating Station".

AmerGen
An Exelon Company

AmerGen Energy Company
Oyster Creek
US Route 9 South, P.O. Box 388
Forked River, NJ 08731-0388
www.exeloncorp.com

FILE

December 21, 2005

2130-05-20244
2120-052-2935

National Marine Fisheries Service Northeast Region
Protected Resources Division
One Blackburn Drive
Gloucester, MA 01930
Attention: Pasquale Scida

Dear Mr. Scida:

Subject: OYSTER CREEK GENERATING STATION (OCGS)
DOCKET NO. 50-219
ANNUAL SEA TURTLE INCIDENTAL TAKE REPORT - 2005

Enclosed is a copy of the 2005 Annual Sea Turtle Incidental Take Report for the Oyster Creek Generating Station. The report is submitted in accordance with Condition 10 of the Incidental Take Statement of the OCGS Endangered Species Act Biological Opinion.

If you have any questions concerning this submittal, please contact Ms. Kathy Barnes, Sr. Regulatory Specialist at 609-971-4970 or Mr. Malcolm Browne, Environmental Specialist, at 609-971-4124.

Sincerely,

Bud Swenson
Vice President
Oyster Creek

BS/DF

Enclosure

cc: NRC Document Control Desk
Administrator, Region I
NRC Project Manager
Senior Resident Inspector

716

ANNUAL REPORT OF SEA TURTLE INCIDENTAL TAKES - 2005

OYSTER CREEK GENERATING STATION

LICENSE NO. DPR-16

DOCKET NO. 50-219

Prepared by:

AMERGEN ENERGY COMPANY

December 2005

Introduction

The Annual Report of Sea Turtle Incidental Takes provides a summary of the incidental takes of all species of sea turtles at the Oyster Creek Generating Station (OCGS) during the past year. The report is required by Condition 10 of the Incidental Take Statement of the OCGS Endangered Species Act, Section 7 Consultation, Biological Opinion. This report covers all incidental takes which occurred during 2005.

Incidental Take Reports documenting the circumstances of incidental takes of sea turtles are completed following any OCGS sea turtle incidental take and are provided to NMFS and USNRC. Incident reports concerning the taking of endangered sea turtles entitled "Sea Turtle Incidental Take Report 2005-1 and 2005-2" are provided as Attachments I and II, respectively. The circumstances surrounding the two incidental takes that occurred during 2005 are summarized below. In both cases the incidental takes were reported to the Nuclear Regulatory Commission and the National Marine Fisheries Service within 24 hours of the incidental take. Inspections and cleaning of cooling water intake trash bars continue to be conducted in accordance with Conditions 1 and 4 of the Incidental Take Statement.

INCIDENTAL TAKE OF JULY 4, 2005

At approximately 9:05 AM on Monday July 4, 2005, an OCGS Operator performing a routine cleaning of the trash racks noticed a sea turtle among the vegetation, seaweed and debris removed from Bay # 4 of the dilution water intake structure. The turtle was retrieved as gently as possible using only a dipnet. It appeared to be dead and slightly decomposed, indicating that it may have died several hours or more prior to collection. In accordance with OCGS procedures, Operators initiated resuscitation of the sea turtle but were unable to revive it. The Marine Mammal Stranding Center representative who took custody of the turtle confirmed it to be a juvenile Kemp's ridley sea turtle (Lepidochelys kempi). The water temperature at the time of the incidental take was approximately 24.3°C (75.8°F) and the OCGS was operating at 100 percent power with four circulating water pumps and two dilution pumps in operation. Although it is impossible to say precisely how long the turtle had been on the trash bars prior to removal, the dilution water trash racks had been inspected earlier the same day at approximately 5:00 AM. The turtle was not observed during that trash rack inspection and cleaning.

The turtle measured 23.2 cm (9.1 in) carapace length straight line and weighed 1.4 kg (3.0 lb). The turtle exhibited some severe slice wounds including a partially crushed and sliced skull as well as a sliced carapace, most probably the result of a boat propeller collision. Some small scrapes were observed on the ventral surface of the carapace. It was not possible to determine definitively whether the turtle had died prior to arriving at OCGS or as a result of interaction with the OCGS intake. No tags were present on the turtle when taken. USNRC and NMFS personnel were notified of the incidental take within 24 hours.

The turtle was taken to the MMSC in Brigantine, NJ during the early afternoon on July 4, 2005. At the MMSC, the turtle was examined, photographed and measured and a necropsy was performed. MMSC personnel indicated that the necropsy indicated that the turtle was an immature male with no digesta present in the esophagus or small intestine. The necropsy indicated the cause of death may have been the result of a prop or skeg wound. The turtle was buried by MMSC personnel at Brigantine, NJ.

INCIDENTAL TAKE OF AUGUST 5, 2005

At approximately 5:00 AM on Friday August 5, 2005, an OCGS operator performing a routine cleaning of the trash racks noticed a live sea turtle swimming below the water surface within Bay # 4 of the dilution water intake structure. The operator retrieved the turtle as gently as possible. The turtle appeared to be alive and moving about normally but a wound to a portion of the

left front flipper was apparent. The injury indicated a previous entanglement with a line or net. The Marine Mammal Stranding Center representative who took custody of the turtle the same morning confirmed it to be a juvenile Kemp's ridley sea turtle (Lepidochelys kempi). The water temperature at the time of the incidental take was approximately 28.2°C (82.7°F) and the OCGS was operating at 100 percent power with four circulating water pumps and two dilution pumps in operation. Although it is impossible to say precisely how long the turtle had been on the trash bars prior to removal, the dilution water trash racks had been inspected only about one hour earlier the same day at approximately 4:00 AM. The turtle was not observed during that inspection.

The turtle measured 23.6 cm (9.3 in) carapace length straight line and weighed 1.9 kg (4.2 lb). The turtle exhibited the previously mentioned wound to the left front flipper. However, the turtle appeared to be in good health and moving about normally after its gentle retrieval from the water at OCGS. No external tags were present on the turtle when taken. USNRC and NMFS personnel were notified of the incidental take within 24 hours.

The turtle was taken to the MMSC in Brigantine, NJ during the morning of August 5, 2005. At the MMSC, the turtle was examined, photographed and held to ensure it was feeding well. The turtle was transferred August 6, 2005 to the Karen Beasley Sea Turtle Rescue and Rehabilitation Center in Topsail Island, NC for further rehabilitation. The turtle was again transferred August 12, 2005 to the North Carolina State Veterinary School, where amputation of the turtle's left front flipper was performed.

Comparison of Annual Sea Turtle Incidental Takes With Prior Years

Regarding trends in the number of incidental sea turtle takes at the OCGS, two incidental takes occurred during 2005 which is similar to the longterm average of slightly over two incidental takes per year recorded over the last decade. However, the annual abundance of sea turtles in this vicinity appears to be highly variable, unpredictable, and unrelated to the operation of the OCGS. There are several factors that may influence the number of sea turtle incidental takes which occur at the OCGS. Barnegat Inlet, the only tidal inlet in the vicinity of Oyster Creek, which provides access to Barnegat Bay from the Atlantic Ocean, was deepened during dredging operations in the early 1990's. Completion of the Barnegat Inlet dredging operation resulted in an increase in the tidal prism, or volume of water entering and exiting the inlet on a single tidal cycle, as well as a slightly greater tidal range at Oyster Creek. The deepening of Barnegat Inlet and associated waterway channels was completed immediately prior to 1992, when incidental takes of sea turtles began to occur at OCGS, and may partially explain the occurrence of the turtles.

It is likely that the local variability of sea turtle abundance is also related to biological factors including the abundance of organisms on which sea turtles prefer to feed, such as blue crabs, horseshoe crabs, and calico crabs. Blue crabs have been particularly abundant in Barnegat Bay in recent years, in contrast to other coastal bays along the Atlantic coast such as Chesapeake Bay. Physical factors, such as an oceanic front or an oceanic gyre occurring unusually close to Barnegat Inlet, may also play a part in the prevalence of sea turtles near Oyster Creek because oceanic fronts have been shown to be used as a migratory and forage habitat by sea turtles (Polovina et al, 2000). Experience has also shown that the passage of a severe storm or pressure system near Barnegat Inlet can cause major increases in winds, waves, tides and tidal prism in shallow estuarine waters such as Barnegat Bay. These events could increase the likelihood of slowly swimming organisms such as sea turtles occurring in the estuary. Despite the record number of named tropical storms and hurricanes that occurred during 2005, few major tropical storms occurred along the local portion of the Atlantic coast which could have caused sea turtles to seek or remain within shallow estuarine areas such as Barnegat Bay for longer periods of time than normal.

Many years of environmental sampling conducted near the OCGS have repeatedly demonstrated that the abundance of various marine organisms can vary considerably from year to year, often by orders of magnitude. This is particularly true for seasonal migrants, whose abundance in Barnegat Bay is highly dependent upon physical and biological factors along the migratory route. Therefore, the observed annual variation in sea turtle incidental takes at the OCGS from a minimum of zero to a maximum of eight per year is not considered particularly significant. The ultimate goal of the considerable effort being put forward at the OCGS for the protection of sea turtles is to protect the turtles that do arrive at the plant, and to release as many turtles as possible to safety. The OCGS program for

the protection of threatened and endangered sea turtles can be considered to be quite successful because most of the sea turtles incidentally captured at OCGS since 1992 have subsequently been released alive and well, to the Atlantic Ocean in locations free from potential cold-shock, due to the efforts of OCGS personnel.

The two incidental takes of Kemp's ridley turtles during 2005 at the OCGS did not exceed the Incidental Take Statement (ITS) limit, which was recently increased to a maximum of eight Kemp's ridleys per year with no more than four lethal takes per year. The one lethal Kemp's ridley take at the OCGS during 2005 was determined by necropsy to have most likely been the result of a collision with a boat. This is a particularly plausible explanation given that the turtle was taken on July 4, which is typically the date of heaviest recreational boat traffic in Barnegat Bay near the OCGS.

References

Polovina, J.J., D.R. Kobayashi, D.M. Ellis, M.P. Seki, and G.H. Balazs. 2000. Turtles on the edge: Movement of loggerhead turtles (Caretta caretta) along oceanic fronts in the central North Pacific, 1997-1998. Fish. Oceanogr., 9: 71-82.

ATTACHMENT I

SEA TURTLE INCIDENTAL TAKE REPORT
2005-1

OYSTER CREEK GENERATING STATION

Sea Turtle Incidental Take Report 2005-1

At approximately 0905 hours on Monday July 4, 2005, an Oyster Creek Generating Station (OCGS) operator performing a routine cleaning of the trash racks noticed a sea turtle among the aquatic vegetation, seaweed and debris accumulated within Bay # 1 of the dilution water intake structure. The operator retrieved the turtle as gently as possible using only a dipnet. The turtle appeared to be dead and slightly decomposed, indicating that it may have died several hours or more prior to collection. The Marine Mammal Stranding Center representative who took custody of the turtle the same morning confirmed it to be a juvenile Kemp's ridley sea turtle (Lepidochelys kempi). The water temperature at the time of the incidental take was approximately 75.8 F (24.3 C) and OCGS was in operation at 100% power with four circulating water pumps and two dilution pumps in operation. Although it is impossible to say precisely how long the turtle had been near the dilution structure prior to removal, the dilution water trash racks and intake bays had been inspected just a few hours earlier the same day at approximately 0500 hours. The turtle was not observed during that inspection and cleaning.

The turtle measured 9.1 in (23.2 cm) carapace length straight line and weighed 3 lb (1.4 kg). The turtle exhibited severe slice wounds including a partially crushed and sliced skull as well as a sliced carapace, most probably the result of a boat propeller collision. Some small scrapes were observed on the ventral surface of the carapace. It was not possible to determine exactly when or how the turtle had died prior to arriving at OCGS. However, because of the nature of its wounds prior to its gentle retrieval from the water at OCGS, its death did not appear to have been a result of interaction with the OCGS intake. No tags were present on the turtle when captured. USNRC and NMFS personnel were notified of the capture within 24 hours on July 4, 2005.

The turtle was taken to the Marine Mammal Stranding Center (MMSC) in Brigantine, NJ during the early afternoon of July 4, 2005. At the MMSC, the turtle was examined, measured and a necropsy performed. The turtle was buried by MMSC personnel in Brigantine, NJ.

SEA TURTLE STRANDI G AND SALVAGE NETWO K – STRANDING REPORT

OBSERVER'S NAME / ADDRESS / PHONE:
First Brandi M.I. ____ Last Biehl
...ation Marine Mammal Stranding Center
Address PO Box 773, 3625 Brigantine Blvd., Brigantine, NJ 08203
Area code/Phone number (609) 266-0538

STRANDING DATE:
Year 20 05 Month 07 Day 04
Turtle number by day 01
Field ID # MMSC-05-142
Coordinator must be notified within 24 hrs; this was done by [x] ***phone (609)266-0538*** [ ] ***email*** [ ] ***fax***

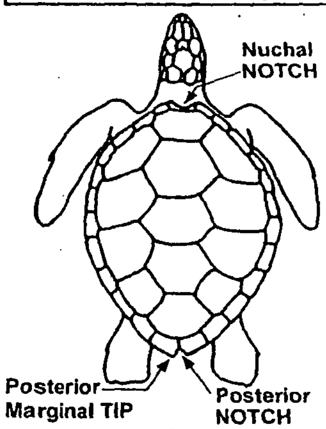
SPECIES: (check one)
- [ ] CC = Loggerhead
- [ ] CM = Green
- [ ] DC = Leatherback
- [ ] EI = Hawksbill
- [x] LK = Kemp's Ridley
- [ ] LO = Olive Ridley
- [ ] UN = Unidentified

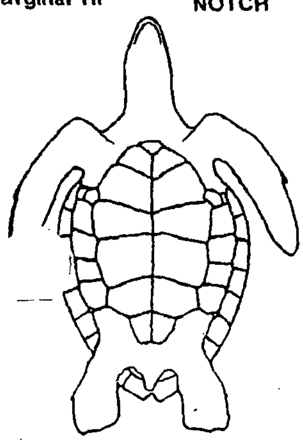
Check Unidentified if not positive. Do Not Guess.

Carcass necropsied? [x] Yes [ ] No
Photos taken? [x] Yes [ ] No
Species verified by coordinator? [ ] Yes [ ] No

SEX:
- [ ] Undetermined
- [ ] Female [x] Male

...ail extend beyond carapace?
...s; how far? ______ cm / in
[x] No
How was sex determined?
- [x] Necropsy
- [ ] Tail length (adult only)





STRANDING LOCATION: [ ] Offshore (Atlantic or Gulf beach) [x] Inshore (bay, river, sound, inlet, etc)
State NJ County Ocean
Descriptive location (be specific) Forked River, Oyster Creek Nuclear Power Plant, impinged On water intake grating.
Latitude 39° 48.85' N Longitude 74° 12.42' W

CONDITION: (check one)
- [ ] 0 = Alive
- [ ] 1 = Fresh dead
- [x] 2 = Moderately decomposed
- [ ] 3 = Severely decomposed
- [ ] 4 = Dried carcass
- [ ] 5 = Skeleton, bones only

FINAL DISPOSITION: (check)
- [ ] 1 = Left on beach where found; painted? [ ] Yes* [ ] No(5)
- [x] 2 = Buried: [x] on beach / [ ] off beach; carcass painted before buried? [ ] Yes* [ ] No
- [x] 3 = Salvaged: [ ] all / [x] part(s), what/why? Muscle for Genetics (NMFS)
- [ ] 4 = Pulled up on beach/dune; painted? [ ] Yes* [ ] No
- [ ] 6 = Alive, released
- [ ] 7 = Alive, taken to rehab. facility, where? ______
- [ ] 8 = Left floating, not recovered; painted? [ ] Yes* [ ] No
- [ ] 9 = Disposition unknown, explain ______

If painted, what color? ______

TAGS: ***Contact coordinator before disposing of any tagged animal!!***
Checked for flipper tags? [x] Yes [ ] No
Check all 4 flippers. If found, record tag number(s) / tag location / return address
None found

PIT tag scan? [x] Yes [ ] No
If found, record number / tag location
None found

Coded wire tag scan? [ ] Yes [x] No
If positive response, record location (flipper)

Checked for living tag? [x] Yes [ ] No
If found, record location (scute number & side)
None found

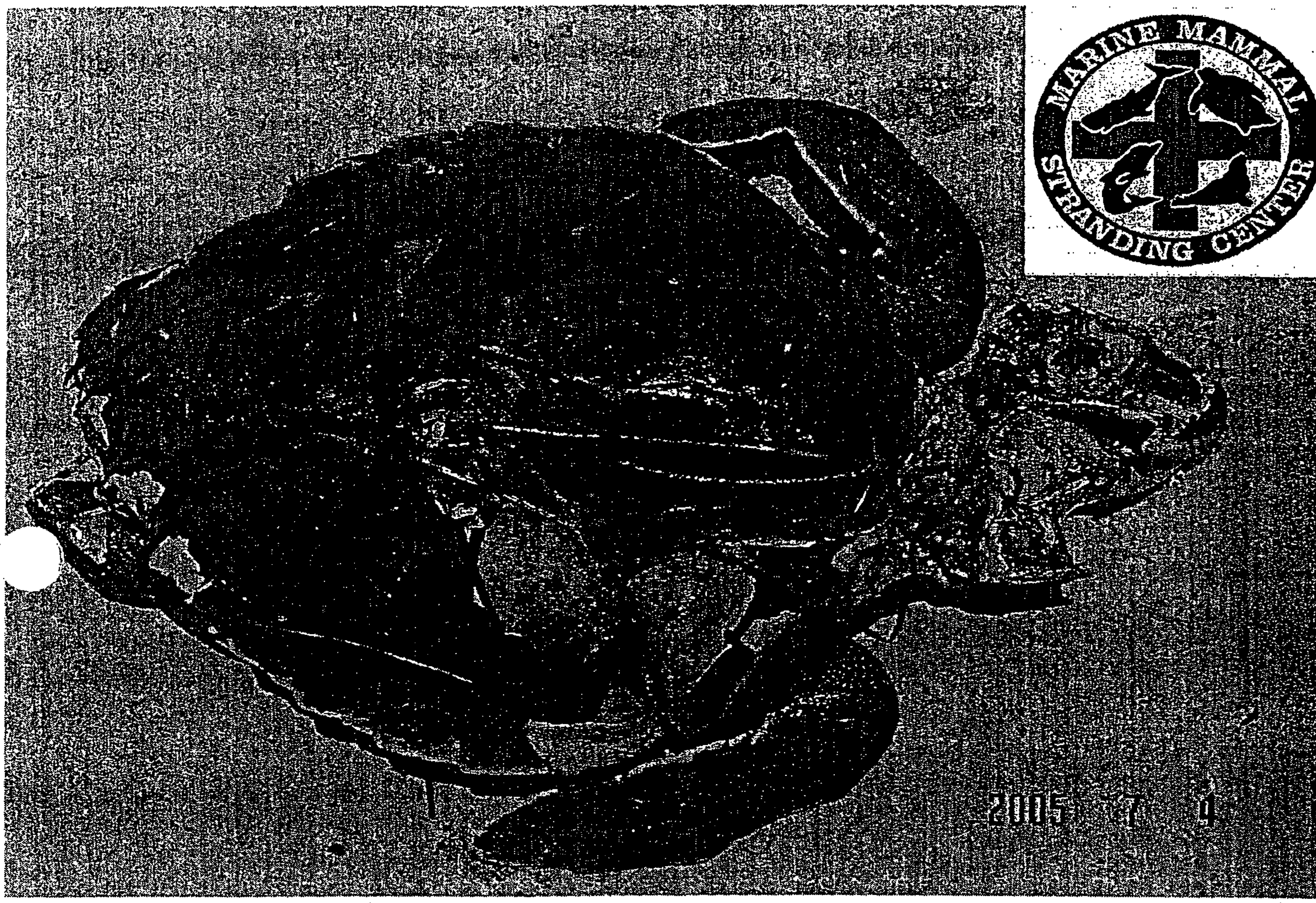
CARAPACE MEASUREMENTS: (*see drawing*)

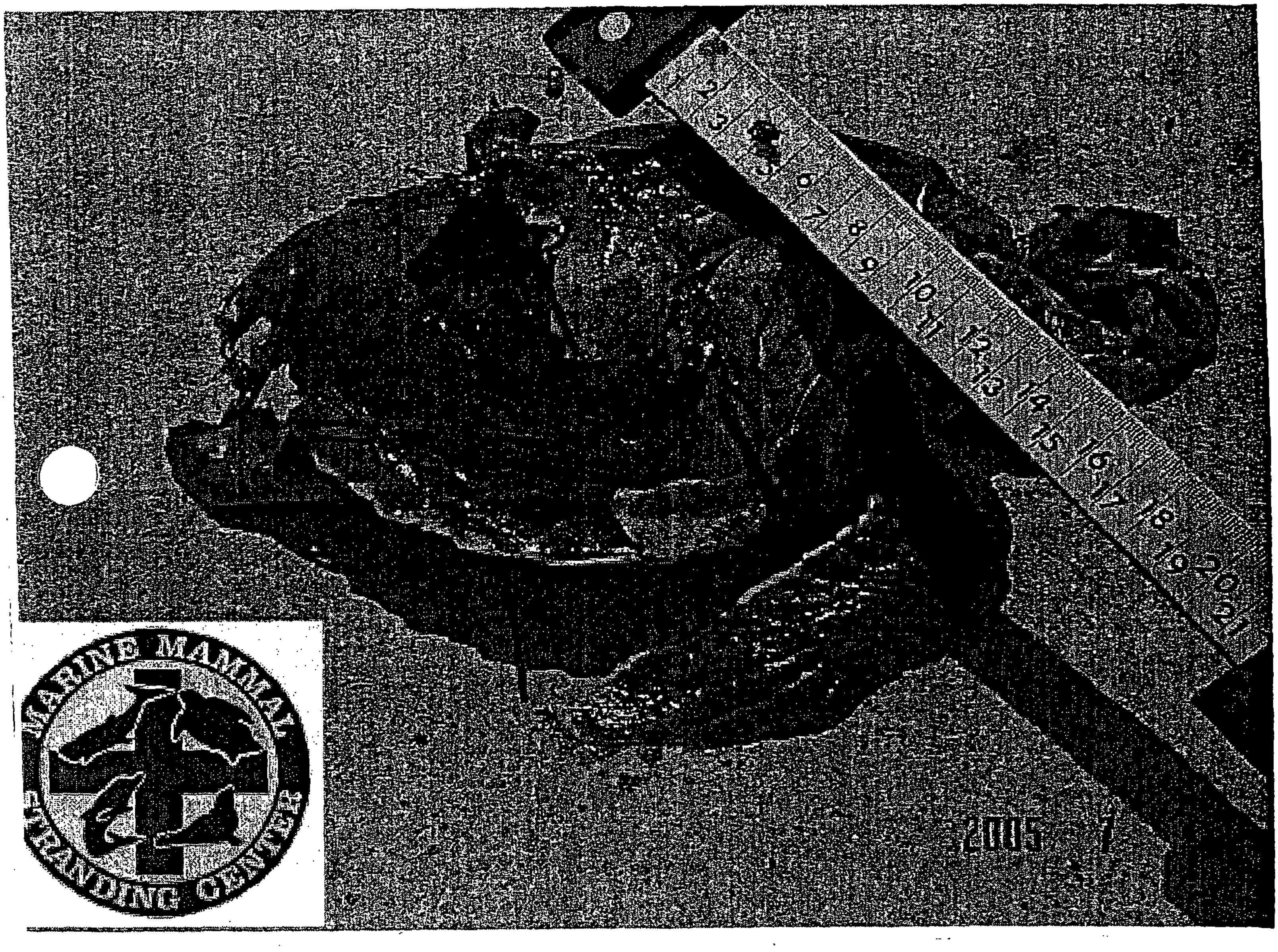
Using calipers		**Circle unit**
Straight length (NOTCH-TIP)	23.2	(cm) / in
Minimum length (NOTCH-NOTCH)		cm / in
Straight width (Widest Point)	21.0	(cm) / in
Using non-metal measuring tape		**Circle unit**
Curved length (NOTCH–TIP)		cm / in
Minimum length (NOTCH-NOTCH)		cm / in
Curved width (Widest Point)		cm / in
		Circle unit
Weight [x] actual / [ ] est.	3.0	kg / (lb)

Mark wounds / abnormalities on diagrams at left and describe below (note tar or oil, gear or debris entanglement, propeller damage, epibiota, papillomas, emaciation, etc.). **Please note if no wounds / abnormalities are found.**
Skull crushed through right orbital (possible prop strike). Right carapace near shoulder (RFF) cracked (possible prop or skeg wound). Unable to determine if injuries were pre or post-mortem. Photos, measurements, necropsy and burial by MMSC staff. Esophagus: lined with a black, gritty material. Stomach: devoid of any ingesta. Small intestine: milky-yellow mucous, no digesta present. Large intestine/colon: dark-brown, moist, loosely formed feces. Heart: no observed parasites, no gross lesions. Sex determined by necropsy: immature male.

OYSTER CREEK GENERATING STATION

Sea Turtle Incidental Take Report 2005-1

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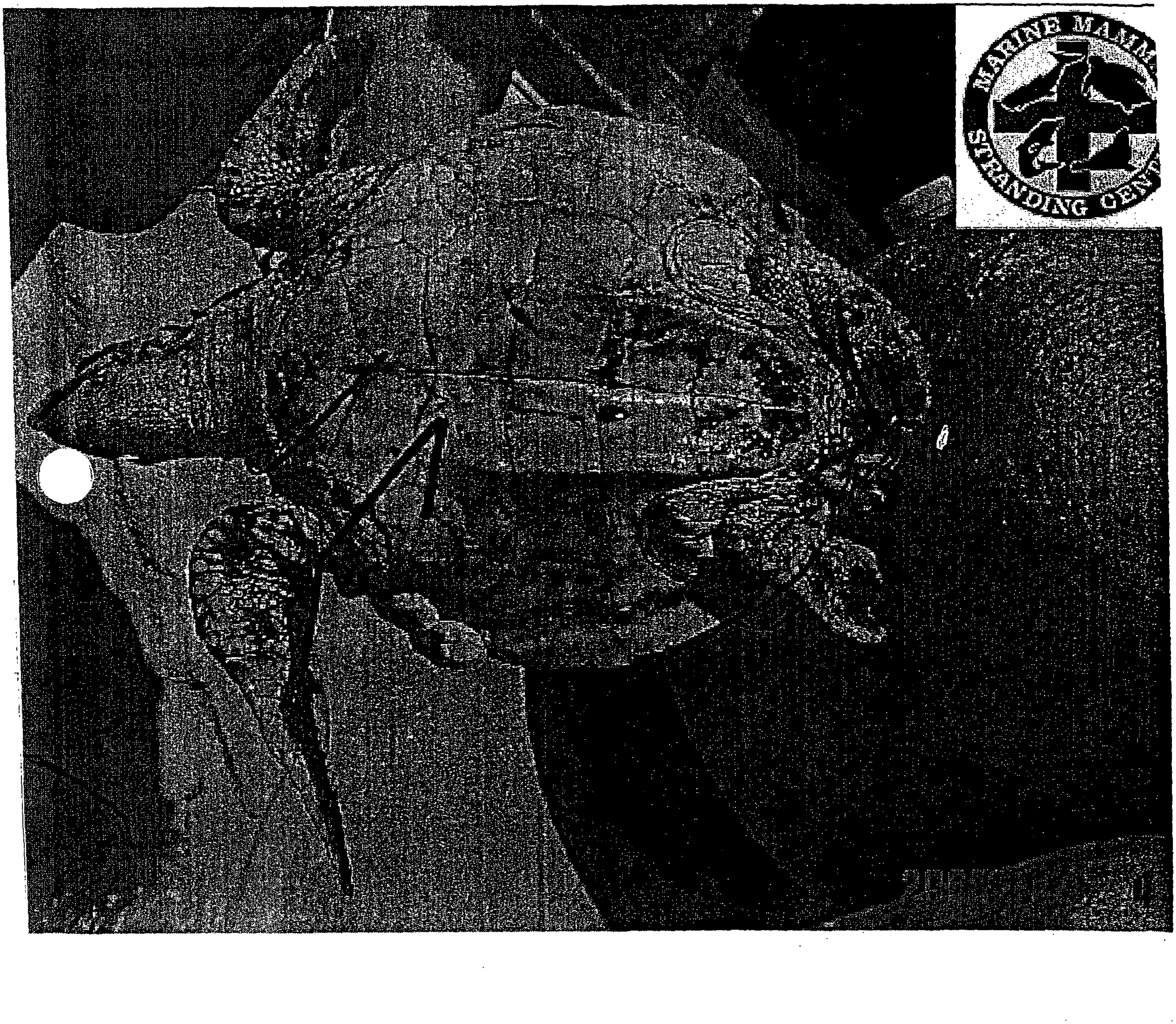
STRANDING CENTER
2005 7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MARINE MAMMAL
STRANDING CENTER
2005

ATTACHMENT II

SEA TURTLE INCIDENTAL TAKE REPORT
2005-2

OYSTER CREEK GENERATING STATION

Sea Turtle Incidental Take Report 2005-2

At approximately 0500 hours on Friday August 5, 2005, an Oyster Creek Generating Station (OCGS) operator performing a routine cleaning of the trash racks noticed a live sea turtle below the water surface within Bay # 4 of the circulating water intake structure. The operator retrieved the turtle as gently as possible. The turtle appeared to be alive and moving about normally but a wound to a portion of the left front flipper was apparent. The Marine Mammal Stranding Center representative who took custody of the turtle the same morning confirmed it to be a juvenile Kemp's ridley sea turtle (Lepidochelys kempi). The water temperature at the time of the incidental take was approximately 82.7 F (28.2 C) and OCGS was in operation at 100% power with four circulating water pumps and two dilution pumps in operation. Although it is impossible to say precisely how long the turtle had been near the circulating water intake structure prior to removal, the circulating water trash racks and intake bays had been inspected only about one hour earlier the same day at approximately 0400 hours. The turtle was not observed during that inspection.

The turtle measured 9.3 in (23.6 cm) carapace length straight line and weighed 4.2 lb (1.9 kg). The turtle exhibited a severe laceration near the base of the left front flipper. However, the turtle appeared to be in good health and moving about normally after its gentle retrieval from the water at OCGS. No tags were present on the turtle when captured. USNRC and NMFS personnel were notified of the capture within 24 hours on August 5, 2005.

The turtle was taken to the Marine Mammal Stranding Center (MMSC) in Brigantine, NJ during the morning of August 5, 2005. At the MMSC, the turtle was examined, measured and held for feeding and rehabilitation. The Sea Turtle Stranding and Salvage Network Stranding Report 05-162 pre The turtle was sent the following day from MMSC to the Sea Turtle Rescue and Rehabilitation Center in Topsail Beach, NC for further rehabilitation and medical evaluation. On August 12, the turtle was transported to the NC State Veterinary School for amputation of the wounded flipper. The turtle will undergo additional rehabilitation before being released into the Atlantic Ocean.

SEA TURTLE STRANDING AND SALVAGE NETWORK – STRANDING REPORT

OBSERVER'S NAME / ADDRESS / PHONE:
First Brandi M.I. N Last Biehl
Affiliation Marine Mammal Stranding Center
Address PO Box 773, 3625 Brigantine Blvd., Brigantine, NJ 08203

Area code/Phone number (609) 266-0538

STRANDING DATE:
Year 20 05 Month 08 Day 5
Turtle number by day 01
Field ID # 05-162
Coordinator must be notified within 24 hrs; this was done by [x] ***phone (609)266-0538***
[ ] ***email*** [ ] ***fax***

SPECIES: (check one)
- [ ] CC = Loggerhead
- [ ] CM = Green
- [ ] DC = Leatherback
- [ ] EI = Hawksbill
- [x] LK = Kemp's Ridley
- [ ] LO = Olive Ridley
- [ ] UN = Unidentified

Check Unidentified if not positive. Do Not Guess.

STRANDING LOCATION: [ ] Offshore (Atlantic or Gulf beach) [x] Inshore (bay, river, sound, inlet, etc)
State NJ County Ocean County
Descriptive location (be specific) Forked River, Oyster Creek Nuclear Power Plant, impinged on water intake grating.

Latitude 39° 48. 85' N Longitude 74° 12. 42' W

CONDITION: (check one)
- [x] 0 = Alive
- [ ] 1 = Fresh dead
- [ ] 2 = Moderately decomposed
- [ ] 3 = Severely decomposed
- [ ] 4 = Dried carcass
- [ ] 5 = Skeleton, bones only

FINAL DISPOSITION: (check)
- [ ] 1 = Left on beach where found; painted? [ ] Yes* [ ] No(5)
- [ ] 2 = Buried: [ ] on beach / [ ] off beach; carcass painted before buried? [ ] Yes* [ ] No
- [ ] 3 = Salvaged: [ ] all / [ ] part(s), what/why?)
- [ ] 4 = Pulled up on beach/dune; painted? [ ] Yes* [ ] No
- [ ] 6 = Alive, released
- [x] 7 = Alive, taken to rehab. facility, where? Topsail Sea Turtle Hospital (Topsail, NC)
- [ ] 8 = Left floating, not recovered; painted? [ ] Yes* [ ] No
- [ ] 9 = Disposition unknown, explain

If painted, what color?

Carcass necropsied? [ ] Yes [x] No
Photos taken? [x] Yes [ ] No
Species verified by coordinator? [x] Yes [ ] No

SEX:
- [x] Undetermined
- [ ] Female [ ] Male

Does tail extend beyond carapace?
- [ ] Yes; how far? ______ cm / in
- [ ] No

How was sex determined?
- [ ] Necropsy
- [ ] Tail length (adult only)

TAGS: ***Contact coordinator before disposing of any tagged animal!!***
Checked for flipper tags? [ ] Yes [x] No
Check all 4 flippers. If found, record tag number(s) / tag location / return address

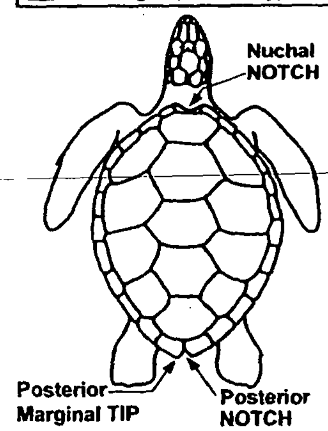
PIT tag scan? [ ] Yes [x] No
If found, record number / tag location

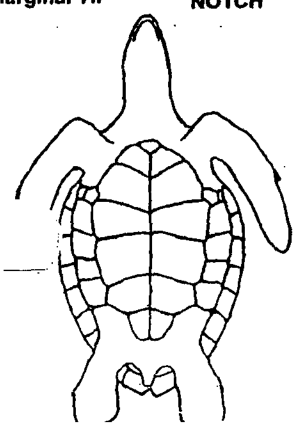
Coded wire tag scan? [ ] Yes [x] No
If positive response, record location (flipper)

Checked for living tag? [ ] Yes [x] No
If found, record location (scute number & side)

CARAPACE MEASUREMENTS: (*see drawing*)

Using calipers		**Circle unit**
Straight length (NOTCH-TIP)	23.6	(cm) / in
Minimum length (NOTCH-NOTCH)		cm / in
Straight width (Widest Point)	21.5	(cm) / in
Using non-metal measuring tape		**Circle unit**
Curved length (NOTCH–TIP)		cm / in
Minimum length (NOTCH-NOTCH)		cm / in
Curved width (Widest Point)		cm / in
		Circle unit
Weight [x] actual / [ ] est.	4.2	kg / (lb)





Mark wounds / abnormalities on diagrams at left and describe below (note tar or oil, gear or debris entanglement, propeller damage, epibiota, papillomas, emaciation, etc.). **Please note if no wounds / abnormalities are found.**

Responsive. Emaciated. Left front flipper has severe laceration extending ¾ of the way across (small amount of muscle and tissue attaching it). Small abrasions to right front flipper. Injuries indicate a previous entanglement in a line or net. Taken to MMSC for evaluation. 08/06/05 Transferred to The Sea Turtle Hospital, Topsail, NC for further rehabilitation. 08/12/05 Left front flipper amputation by NC State Vet School.

BRIGGY	KEMP'S RIDLEY Lepidochelys kempi Juvenile		ADMIT AUG 6, 2005	
		Weight	1.9 kg	
		SCL:	cm	
		SCW:	cm	

THE STRANDING

Found with severe laceration to front flipper.

THE TREATMENT

Transported August 12 to the NC State Vet School for amputation of wounded flipper.

AmerGen

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AmerGen Energy Company
Oyster Creek
US Route 9 South, P.O. Box 388
Forked River, NJ 08731-0388

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July 24, 2006

2130-06-20365
2120-062-2840

US Nuclear Regulatory Commission
Document Control Desk - NRC
Washington, DC 20555

Subject: Oyster Creek Generating Station
Docket 50-219
Sea Turtle Incidental Capture Report 2006-1

This report provides detailed information regarding the recent incidental capture of a juvenile Kemp's Ridley sea turtle at the Oyster Creek Generating Station. The turtle was captured live during the morning of June 30, 2006 after it was removed from the dilution water intake structure trash bars. As indicated on the attached incident report, the turtle was taken to the Marine Mammal Stranding Center in Brigantine, NJ for examination, feeding and eventual release. After confirming that the turtle was feeding and moving about normally, the turtle was released by Marine Mammal Stranding Center personnel into the Atlantic Ocean in Brigantine, NJ on July 5, 2006.

If you have any questions or require additional information, please do not hesitate to contact Mr. Malcolm Browne at (609) 971-4124.

Very truly yours,

James J Randich

James J. Randich
Plant Manager

JJR/KB/MEB
Enclosure
cc: Ms. Carrie Upite
U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Marine Fisheries Service Northeast Region
Protected Resources Division
One Blackburn Drive
Gloucester, MA 01930

cc: Mr. Samuel Collins, Administrator, Region 1
US Nuclear Regulatory Commission
475 Allendale Road
King of Prussia, PA 19406

US Nuclear Regulatory Commission
Senior Project Manager
Washington, DC 20555

Ms. Harriet Nash, Mailstop O-11-F1
US Nuclear Regulatory Commission
Washington, DC 20555

Mr. Michael Masnik, Mailstop O-11-F1
US Nuclear Regulatory Commission
Washington, DC 20555

Senior Resident Inspector
Oyster Creek Generating Station
PO Box 388
Forked River, NJ 08731

Ms. Jeanette Bowers-Altman
NJ Department of Environmental Protection
Division of Fish, Game, and Wildlife
P.O. Box 400
Trenton , NJ 08625-0400

Regulatory Assurance File No. 06024

OYSTER CREEK GENERATING STATION

Sea Turtle Incidental Capture Report 2006-1

At approximately 1100 hours on Friday June 30, 2006, an Oyster Creek Generating Station (OCGS) operator performing a routine cleaning of the trash racks noticed a sea turtle among the vegetation and debris removed from Bay # 1 of the dilution water intake structure. The turtle appeared to be alive and in good condition when captured. OCGS Environmental personnel who took custody of the turtle confirmed it to be a juvenile Kemp's Ridley sea turtle (Lepidochelys kempi). The water temperature at the time of the incidental capture was approximately 78.1 F (25.6 C) and OCGS was in operation at 100% power with four circulating water pumps and two dilution pumps in operation. Although it is impossible to say precisely how long the turtle had been on the trash bars prior to removal, the dilution water trash racks had been inspected earlier the same day at 0500 hours. The turtle was not observed during that trash rack inspection.

The turtle measured 10.8 in (27.3 cm) carapace length straight line and weighed 7.7 lb (3.5 kg). Some small scrapes were observed on the dorsal and ventral (top and bottom) surfaces of the carapace. No tags were present on the turtle when captured. USNRC and NMFS personnel were notified of the capture within 24 hours on June 30, 2006.

The turtle was taken to the Marine Mammal Stranding Center (MMSC) in Brigantine, NJ at approximately 1300 hours on June 30, 2006. At the MMSC, the turtle was examined, fed and observed. After confirming that the turtle was feeding and moving normally, the turtle was released into the Atlantic Ocean by MMSC personnel at 38th Street Beach, Brigantine, NJ on July 5, 2006.

SEA TURTLE STRANDING AND SALVAGE NETWORK – STRANDING REPORT

OBSERVER'S NAME / ADDRESS / PHONE:
First Bill M.I.____ Last Deerr
Affiliation Marine Mammal Stranding Center
Address PO Box 773, 3625 Brigantine Blvd., Brigantine, NJ 08203
Area code/Phone number (609) 266-0538

STRANDING DATE:
Year 20 06 Month 06 Day 30
Turtle number by day 01
Field ID # MMSC-06-076
Coordinator must be notified within 24 hrs; this was done by [x] *phone (609)266-0538* [ ] *email* [ ] *fax*

SPECIES: (check one)
[ ] CC = Loggerhead
[ ] CM = Green
[ ] DC = Leatherback
[ ] EI = Hawksbill
[x] LK = Kemp's Ridley
[ ] LO = Olive Ridley
[ ] UN = Unidentified
Check Unidentified if not positive. Do Not Guess.

STRANDING LOCATION: [ ] Offshore (Atlantic or Gulf beach) [x] Inshore (bay, river, sound, inlet, etc)
State New Jersey County Ocean County
Descriptive location (be specific) Forked River, Oyster Creek Nuclear Power Plant, Impinged on water intake
Latitude 39.81417°N Longitude 74.20700°W

Carcass necropsied? [ ] Yes [x] No
Photos taken? [x] Yes [ ] No
Species verified by coordinator? [x] Yes [ ] No

CONDITION: (check one)
[x] 0 = Alive
[ ] 1 = Fresh dead
[ ] 2 = Moderately decomposed
[ ] 3 = Severely decomposed
[ ] 4 = Dried carcass
[ ] 5 = Skeleton, bones only

FINAL DISPOSITION: (check)
[ ] 1 – Left on beach where found; painted? [ ] Yes* [ ] No(5)
[ ] 2 – Buried: [ ] on beach / [ ] off beach; carcass painted before buried? [ ] Yes* [ ] No
[ ] 3 = Salvaged: [ ] all / [ ] part(s), what/why? ________
[ ] 4 = Pulled up on beach/dune; painted? [ ] Yes* [ ] No
[x] 6 = Alive, released
[x] 7 = Alive, taken to rehab. facility, where? MMSC Released 07/05/2006
[ ] 8 = Left floating, not recovered; painted? [ ] Yes* [ ] No
[ ] 9 = Disposition unknown, explain: ________
*If painted, what color? ________

SEX:
[x] Undetermined
[ ] Female [ ] Male
Does tail extend beyond carapace?
[ ] Yes; how far? ______ cm / in
[x] No
How was sex determined?
[ ] Necropsy
[ ] Tail length (adult only)

TAGS: *Contact coordinator before disposing of any tagged animal!*
Checked for flipper tags? [x] Yes [ ] No
Check all 4 flippers. If found record tag number(s) / tag location / return address

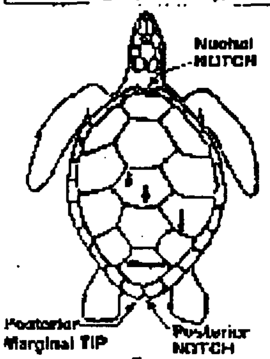
PIT tag scan? [ ] Yes [x] No
If found, record number / tag location

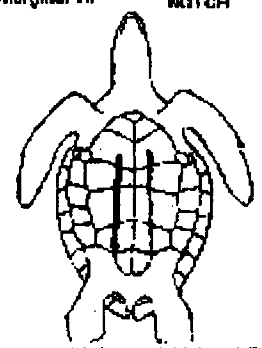
Coded wire tag scan? [ ] Yes [x] No
If positive response, record location (flipper)

Checked for living tag? [x] Yes [ ] No
If found, record location (scute number & side)

CARAPACE MEASUREMENTS: (see drawing)

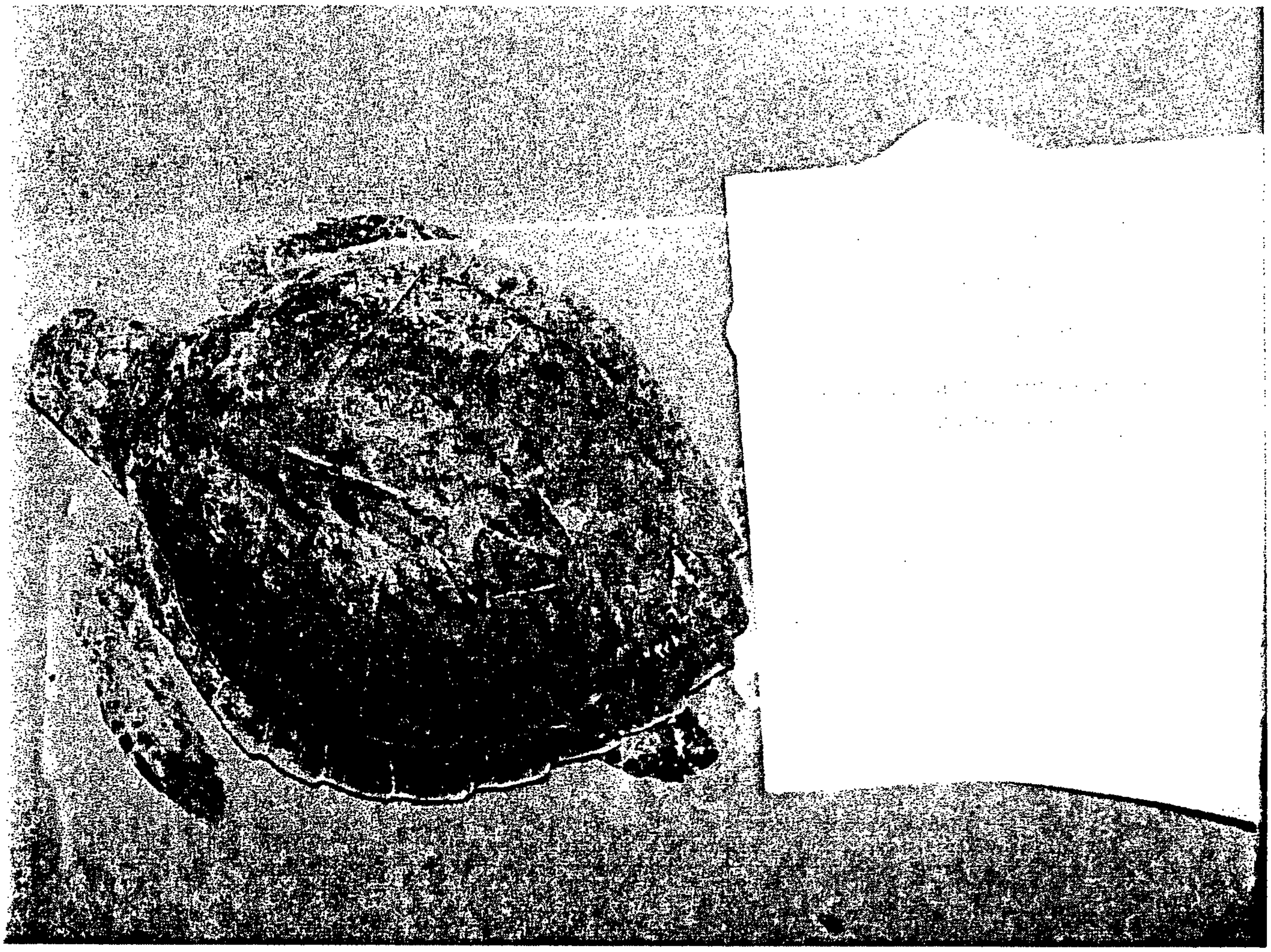
		Circle unit
Using calipers		
Straight length (NOTCH-TIP)	27.3	cm / in
Minimum length (NOTCH-NOTCH)		cm / in
Straight width (Widest Point)	25.8	cm / in
Using non-metal measuring tape		
Curved length (NOTCH-TIP)		cm / in
Minimum length (NOTCH NOTCH)		cm / in
Curved width (Widest Point)		cm / in
Weight [x] actual / [ ] est.	7.7	kg / lb





Mark wounds / abnormalities on diagrams at left and describe below (note tar or oil, gear or debris entanglement, propeller damage, epibiota, papillomas, emaciation, etc.). **Please note if no wounds / abnormalities are found.**

minor abrasions on carapace and plastron from water intake grate; observed for several days; eating well on own and diving with out difficulty; tagged LFF with metal tag #SSL178; released 07/05/2006 at 38th St. beach, Brigantine, NJ Lat: 39.38917 °N Long: 74.38687 °W



AmerGen Energy Company
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Forked River, NJ 08731-0388

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AmerGen
An Exelon Company

August 14, 2006

2130-06-20382
2120-062-2980

US Nuclear Regulatory Commission
Document Control Desk - NRC
Washington, DC 20555

Subject: Oyster Creek Generating Station
Docket 50-219
Sea Turtle Incidental Take Reports 2006-2, 2006-3, 2006-4 & 2006-5

This report provides detailed information regarding the recent incidental takes of three juvenile Kemp's ridley sea turtles and one adult loggerhead sea turtle at the Oyster Creek Generating Station. The turtles were taken 17 July, 19 July, 25 July, and 1 August 2006 from the intake water structure trash bars. As indicated on the attached incident reports, the turtles taken alive on 17 July, 19 July, and 1 August were turned over to the custody of the Marine Mammal Stranding Center (MMSC) in Brigantine, NJ for examination, feeding and subsequent release. These turtles were all released to the Atlantic Ocean by MMSC personnel.

The turtle taken 25 July was not alive when taken and was transferred to the Marine Mammal Stranding Center for subsequent necropsy. Final necropsy results indicated that the turtle was moderately decomposed and parts of its carapace were crushed. Time and cause of death were indeterminate.

If you have any questions or require additional information, please do not hesitate to contact Mr. Malcolm Browne at (609) 971-4124.

Very truly yours,

James Randich

James Randich
Plant Manager

JRR/MEB
Enclosures
cc: Julie Crocker
U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Marine Fisheries Service Northeast Region
Protected Resources Division
One Blackburn Drive
Gloucester, MA 01930

cc: Pasquale Scida
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Marc Ferdas
NRC Senior Resident Inspector
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Jeanette Bowers-Altman
NJ Department of Environmental Protection
Division of Fish, Game, and Wildlife
P.O. Box 400
Trenton, NJ 08625-0400

Regulatory Assurance File No. 06024

OYSTER CREEK GENERATING STATION

Sea Turtle Incidental Take Report 2006-2

At approximately 0935 hours on Monday July 17, 2006, an Oyster Creek Generating Station (OCGS) operator performing a routine cleaning of the trash racks noticed a sea turtle under the water within Bay # 5 of the dilution water intake structure. The turtle appeared to be healthy and moving about normally but slowly. OCGS Environmental personnel who took custody of the turtle confirmed it to be a juvenile Kemp's ridley sea turtle (Lepidochelys kempi). The water temperature at the time of the incidental take was approximately 80.1 F (26.7 C) and OCGS was in operation at 100% power with four circulating water pumps and two dilution pumps in operation. Although it is impossible to say precisely how long the turtle had been on the trash bars prior to removal, the dilution water trash racks had been inspected and cleaned earlier the same morning. The turtle was not observed during that trash rack inspection and cleaning.

The turtle measured only 9.9 in (25.2 cm) carapace length straight line and weighed 5.7 lb (2.6 kg). Minor abrasions and bruising were observed on the underside of the neck and flippers. No tags were present on the turtle when captured. USNRC and NMFS personnel were notified of the incidental take within 24 hours.

The turtle was taken to the Marine Mammal Stranding Center (MMSC) in Brigantine, NJ at approximately 1230 hours on July 17, 2006. At the MMSC, the turtle was examined, measured, fed and held for observation prior to release. After confirming that the turtle was healthy and feeding normally, MMSC personnel tagged and released the turtle at the north end of Brigantine, NJ on July 19, 2006.

SEA TURTLE STRANDING AND SALVAGE NETWORK – STRANDING REPORT

)BSERVER'S NAME / ADDRESS / PHONE:
'irst Brandi M.I. N Last Biehl
\ffiliation Marine Mammal Stranding Center
\ddress PO Box 773, 3625 Brigantine Blvd., Brigantine, NJ 08203

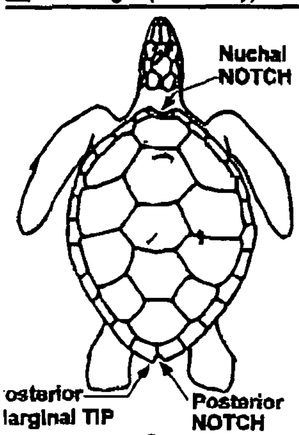
\rea code/Phone number (609) 266-0538

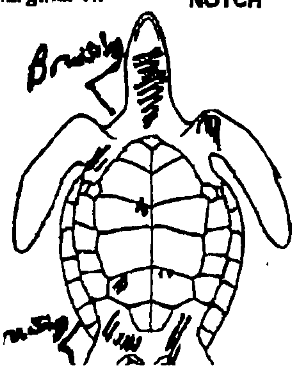
STRANDING DATE:
Year 20 06 Month 07 Day 17
Turtle number by day 01
Field ID # MMSC-06-081
Coordinator must be notified within 24 hrs; this was done by ☒ ***phone (609)266-0538***
☐ ***email*** ☐ ***fax***

SPECIES: (check one)
☐ CC = Loggerhead
☐ CM = Green
☐ DC = Leatherback
☐ EI = Hawksbill
☒ LK = Kemp's Ridley
☐ LO = Olive Ridley
☐ UN = Unidentified
Check Unidentified if not positive. Do Not Guess.

Carcass necropsied? ☐ Yes ☒ No
Photos taken? ☒ Yes ☐ No
Species verified by coordinator?
☒ Yes ☐ No

SEX:
☒ Undetermined
☐ Female ☐ Male
Does tail extend beyond carapace?
☐ Yes; how far? _______ cm / in
☒ No
How was sex determined?
☐ Necropsy
☐ Tail length (adult only)





STRANDING LOCATION: ☐ Offshore (Atlantic or Gulf beach) ☒ Inshore (bay, river, sound, inlet, etc)
State New Jersey County Ocean County
Descriptive location (be specific) Forked River, Oyster Creek Nuclear Power Plant, Impinged on grate

Latitude 39.81417°N Longitude 74.20700°W

CONDITION: (check one)
☒ 0 = Alive
☐ 1 = Fresh dead
☐ 2 = Moderately decomposed
☐ 3 = Severely decomposed
☐ 4 = Dried carcass
☐ 5 = Skeleton, bones only

FINAL DISPOSITION: (check)
☐ 1 = Left on beach where found; painted? ☐ Yes* ☐ No(5)
☐ 2 = Buried: ☐ on beach / ☐ off beach; carcass painted before buried? ☐ Yes* ☐ No
☐ 3 = Salvaged: ☐ all / ☐ part(s), what/why? ________

☐ 4 = Pulled up on beach/dune; painted? ☐ Yes* ☐ No
☒ = Alive, released
☒ 7 = Alive, taken to rehab. facility, where? MMSC, released 7/19/06
☐ 8 = Left floating, not recovered; painted? ☐ Yes* ☐ No
☐ 9 = Disposition unknown, explain ________

If painted, what color? ________

TAGS: ***Contact coordinator before disposing of any tagged animal!!***
Checked for flipper tags? ☒ Yes ☐ No
Check all 4 flippers. If found, record tag number(s) / tag location / return address

PIT tag scan? ☒ Yes ☐ No
If found, record number / tag location

Coded wire tag scan? ☐ Yes ☒ No
If positive response, record location (flipper)

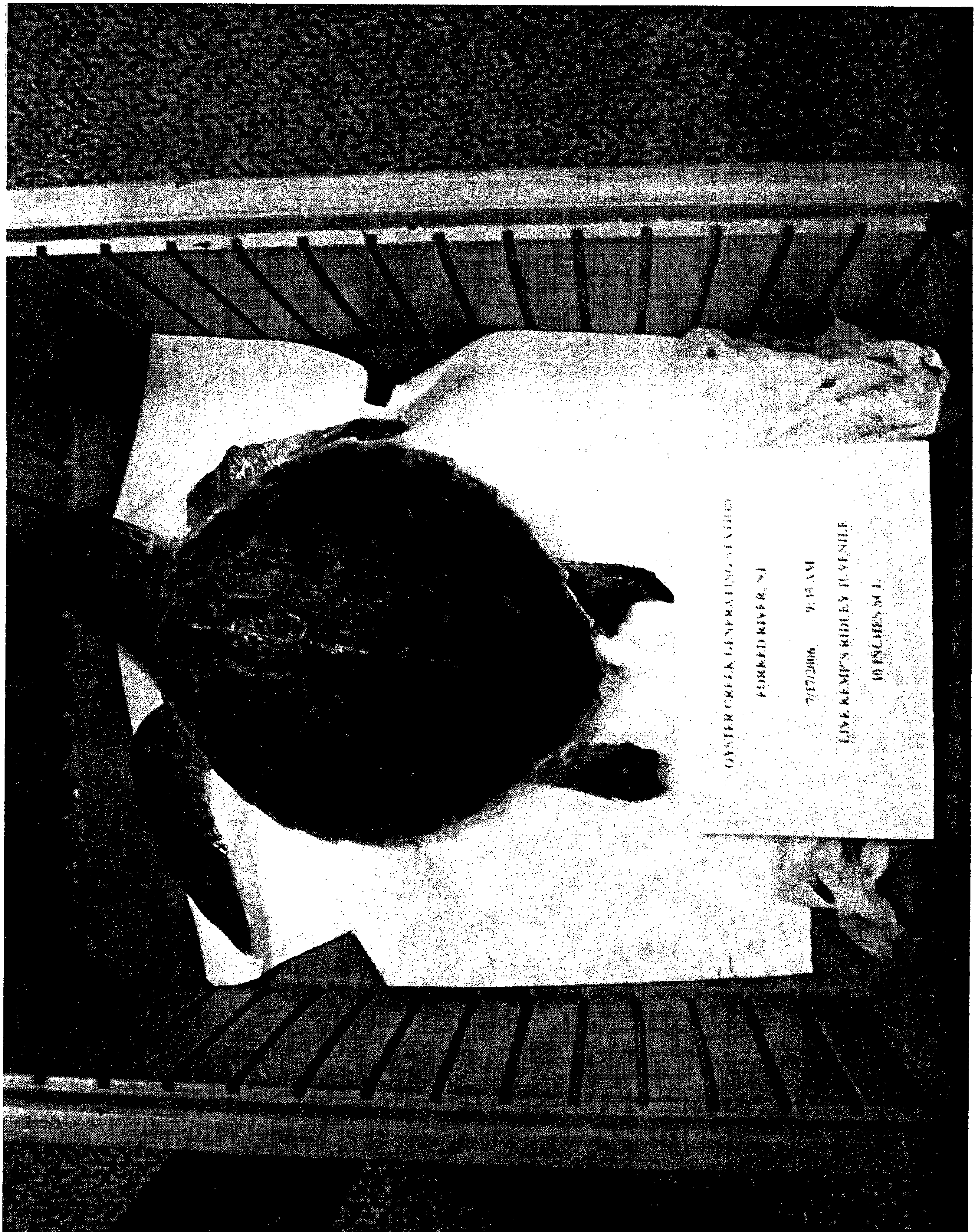
Checked for living tag? ☒ Yes ☐ No
If found, record location (scute number & side)

CARAPACE MEASUREMENTS: (*see drawing*)

Using calipers		**Circle unit**
Straight length (NOTCH-TIP)	25.2	[cm] / in
Minimum length (NOTCH-NOTCH)		cm / in
Straight width (Widest Point)	24	[cm] / in
Using non-metal measuring tape		**Circle unit**
Curved length (NOTCH–TIP)		cm / in
Minimum length (NOTCH-NOTCH)		cm / in
Curved width (Widest Point)		cm / in
		Circle unit
Weight ☒ actual / ☐ est.	5.8	kg / [lb]

Mark wounds / abnormalities on diagrams at left and describe below (note tar or oil, gear or debris entanglement, propeller damage, epibiota, papillomas, emaciation, etc.). **Please note if no wounds / abnormalities are found.**

Minor abrasions on carapace ,plastron, and head. Severe bruising on neck and base of all four flippers. Had been trapped on power plant grate. Turtle was lethargic during transport, but it became alert and responsive at MMSC. Taken to MMSC for rehab. Observed for several days. Tagged RFF with metal tag #SSL115; released 07/19/2006 at the north end Brigantine, NJ Lat: 39.44361 °N Long: 74.33333 °W


OYSTER CREEK GENERATING STATION
FORKED RIVER, NJ
LIVE KEMP'S RIDLEY JUVENILE

OC 2006- 2

OYSTER CREEK GENERATING STATION

Sea Turtle Incidental Take Report 2006-3

At approximately 2130 hours on Wednesday July 19, 2006, an Oyster Creek Generating Station (OCGS) operator performing a routine cleaning of the trash racks noticed a sea turtle among the vegetation and debris removed from Bay # 1 of the circulating water intake structure. The turtle appeared to be healthy, alert and moving about normally. OCGS Environmental personnel confirmed it to be a juvenile Kemp's ridley sea turtle (Lepidochelys kempi). The water temperature at the time of the incidental take was approximately 82.5 F (28.1 C) and OCGS was in operation at 100% power with four circulating water pumps and two dilution pumps in operation. Although it is impossible to say precisely how long the turtle had been on the trash bars prior to removal, the circulating water trash racks had been inspected at 2110 hours the same evening. The turtle was not observed during that trash rack inspection and cleaning.

The turtle measured only 10.5 in (26.7 cm) carapace length straight line and weighed 7.1 lb (3.2 kg). The turtle had no obvious wounds but had a minor amount of bruising or scrapes along its plastron (the underside of its carapace). USNRC and NMFS personnel were notified of the incidental take within 24 hours.

The turtle was taken to the Marine Mammal Stranding Center (MMSC) in Brigantine, NJ later the night of the incidental take. At the MMSC, the turtle was examined, measured, fed and held for subsequent release. After confirming that the turtle was healthy and feeding normally, MMSC personnel tagged and released the turtle at the north end of Brigantine, NJ on July 23, 2006.

SEA TURTLE STRANDING AND SALVAGE NETWORK – STRANDING REPORT

OBSERVER'S NAME / ADDRESS / PHONE:
First Brandi M.I. N Last Biehl
Affiliation Marine Mammal Stranding Center
Address PO Box 773, 3625 Brigantine Blvd., Brigantine, NJ 08203

Area code/Phone number (609) 266-0538

STRANDING DATE:
Year 20 06 Month 07 Day 19
Turtle number by day 01
Field ID # MMSC-06-082
Coordinator must be notified within 24 hrs; this was done by ■ ***phone (609)266-0538*** ☐ ***email*** ☐ ***fax***

SPECIES: (check one)
☐ CC = Loggerhead
☐ CM = Green
☐ DC = Leatherback
☐ EI = Hawksbill
■ LK = Kemp's Ridley
☐ LO = Olive Ridley
☐ UN = Unidentified
Check Unidentified if not positive. Do Not Guess.

STRANDING LOCATION: ☐ Offshore (Atlantic or Gulf beach) ■ Inshore (bay, river, sound, inlet, etc)
State New Jersey County Ocean County
Descriptive location (be specific) Forked River, Oyster Creek Nuclear Power Plant, Impinged on grate
Latitude 39.81417°N Longitude 74.20700°W

Carcass necropsied? ☐ Yes ■ No
Photos taken? ■ Yes ☐ No
Species verified by coordinator? ■ Yes ☐ No

CONDITION: (check one)
■ 0 = Alive
☐ 1 = Fresh dead
☐ 2 = Moderately decomposed
☐ 3 = Severely decomposed
☐ 4 = Dried carcass
☐ 5 = Skeleton, bones only

FINAL DISPOSITION: (check)
☐ 1 = Left on beach where found; painted? ☐ Yes* ☐ No(5)
☐ 2 = Buried: ☐ on beach / ☐ off beach; carcass painted before buried? ☐ Yes* ☐ No
☐ 3 = Salvaged: ☐ all / ☐ part(s), what/why?
☐ 4 = Pulled up on beach/dune; painted? ☐ Yes* ☐ No
■ = Alive, released
■ 7 = Alive, taken to rehab. facility, where? MMSC
☐ 8 = Left floating, not recovered; painted? ☐ Yes* ☐ No
☐ 9 = Disposition unknown, explain
If painted, what color?

SEX:
■ Undetermined
☐ Female ☐ Male
Does tail extend beyond carapace?
■ Yes; how far? 1 cm / in
☐ No
How was sex determined?
☐ Necropsy
☐ Tail length (adult only)

TAGS: ***Contact coordinator before disposing of any tagged animal!!***
Checked for flipper tags? ■ Yes ☐ No
Check all 4 flippers. If found, record tag number(s) / tag location / return address

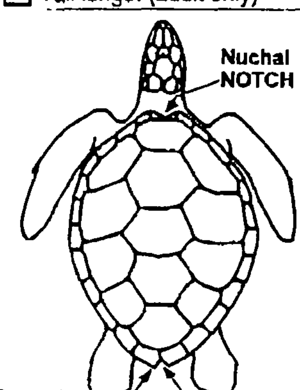
PIT tag scan? ■ Yes ☐ No
If found, record number / tag location

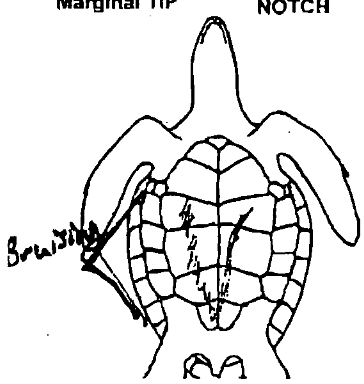
Coded wire tag scan? ☐ Yes ■ No
If positive response, record location (flipper)

Checked for living tag? ■ Yes ☐ No
If found, record location (scute number & side)

CARAPACE MEASUREMENTS: (*see drawing*)

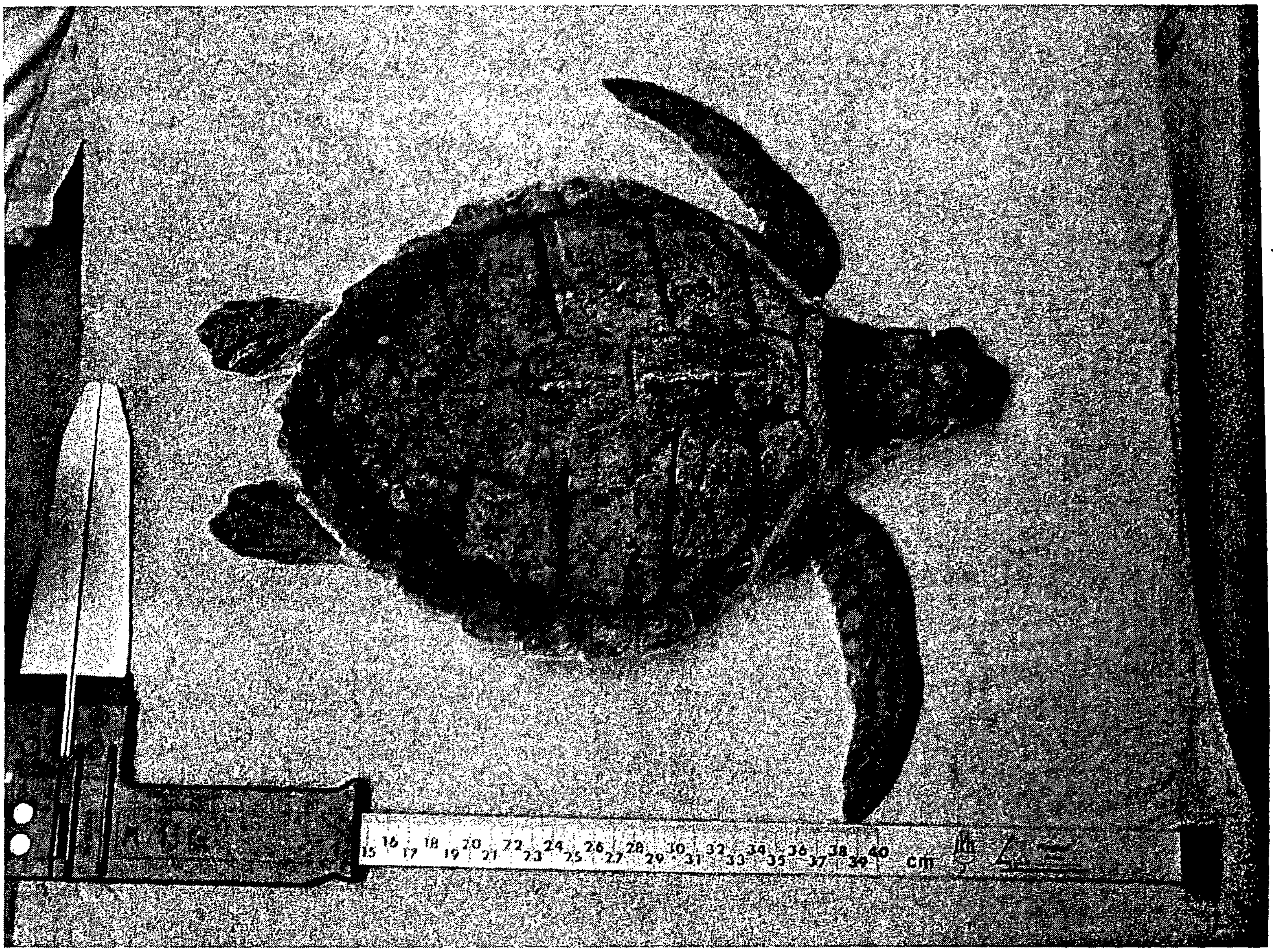
Using calipers		**Circle unit**
Straight length (NOTCH-TIP)	26.7	cm / in
Minimum length (NOTCH-NOTCH)		cm / in
Straight width (Widest Point)	24.8	cm / in
Using non-metal measuring tape		**Circle unit**
Curved length (NOTCH-TIP)		cm / in
Minimum length (NOTCH-NOTCH)		cm / in
Curved width (Widest Point)		cm / in
		Circle unit
Weight ■ actual / ☐ est.	7.1	kg / lb





Mark wounds / abnormalities on diagrams at left and describe below (note tar or oil, gear or debris entanglement, propeller damage, epibiota, papillomas, emaciation, etc.). **Please note if no wounds / abnormalities are found.**

Turtle was taken to MMSC for observation after being impinged on grate. It was alert and responsive during transport and at the center. There was a small amount of algae on carapace, and minor bruising to the plastron. observed for several days; eating well on own and diving with out difficulty; tagged LFF with metal tag #SSL116; released 07/23/2006 at the North end of Brigantine, NJ Lat: 39.44361 °N Long: 74.33333°W


15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 cm

OC 2006- 3

OYSTER CREEK GENERATING STATION

Sea Turtle Incidental Take Report 2006-4

At approximately 0425 hours on Tuesday July 25, 2006 an Oyster Creek Generating Station (OCGS) operator performing a routine cleaning of the trash racks noticed a sea turtle among the vegetation and debris removed from Bay # 4 of the dilution water intake structure. The turtle appeared to be dead and moderately decomposed. OCGS Environmental personnel who took custody of the turtle confirmed it to be a juvenile Kemp's ridley sea turtle (Lepidochelys kempi). The water temperature at the time of the incidental take was approximately 82.2 F (27.9 C) and OCGS was in operation at 100% power with four circulating water pumps and two dilution pumps in operation. Although it is impossible to say precisely how long the turtle had been on the trash bars prior to removal, the turtle was not observed during the previous trash rack cleaning, which occurred at 0300 hours the same morning. Furthermore, the dilution water trash racks had been inspected at 0150 hours the same morning and the turtle was not observed during that inspection. No tags or scarring from previous tags were present on the turtle when taken. USNRC and NMFS personnel were notified of the take within 24 hours.

The turtle was transferred to the Marine Mammal Stranding Center (MMSC) in Brigantine, NJ the same morning as the incidental take. At the MMSC, the turtle was examined and measured. The turtle measured 11.2 in (28.5 cm) carapace length straight line and weighed 7.2 lb (3.3 kg). The upper left portion of the carapace of the turtle had several scutes, which were broken along a jagged break line on the left side of the turtle. Some of its scutes were peeling away from the internal body tissues. Additionally, there were some other broken scutes on the plastron (lower side of the carapace) and an area of bruising on the lower left portion of the turtle. The pattern of wounds observed on this turtle were not similar to those observed on any turtle previously taken at OCGS. The crushing wounds to the carapace and plastron of this turtle may have resulted from being struck by an object moving quickly and with great force, such as a boat. According to the necropsy performed by MMSC, the wounds observed may have occurred after the turtle was already dead (post-mortem). After completion of the necropsy, MMSC personnel buried the carcass of the turtle on the beach near the north end of Brigantine, NJ.

SEA TURTLE STRANDING AND SALVAGE NETWORK – STRANDING REPORT

OBSERVER'S NAME / ADDRESS / PHONE:
First Brandi M.I. N Last Biehl
Affiliation Marine Mammal Stranding Center
Address PO Box 773, 3625 Brigantine Blvd., Brigantine, NJ 08203
Area code/Phone number (609) 266-0538

STRANDING DATE:
Year 20 06 Month 07 Day 25
Turtle number by day 01
Field ID # MMSC-06-088
Coordinator must be notified within 24 hrs; this was done by [x] ***phone (609)266-0538*** [ ] ***email*** [ ] ***fax***

SPECIES: (check one)
- [ ] CC = Loggerhead
- [ ] CM = Green
- [ ] DC = Leatherback
- [ ] EI = Hawksbill
- [x] LK = Kemp's Ridley
- [ ] LO = Olive Ridley
- [ ] UN = Unidentified

Check Unidentified if not positive. Do Not Guess.

STRANDING LOCATION: [ ] Offshore (Atlantic or Gulf beach) [x] Inshore (bay, river, sound, inlet, etc)
State New Jersey County Ocean County
Descriptive location (be specific) Forked River, Oyster Creek Nuclear Power Plant, Impinged on grate
Latitude 39.81417°N Longitude 74.20700°W

Carcass necropsied? [x] Yes [ ] No
Photos taken? [x] Yes [ ] No
Species verified by coordinator? [x] Yes [ ] No

CONDITION: (check one)
- [ ] 0 = Alive
- [ ] 1 = Fresh dead
- [x] 2 = Moderately decomposed
- [ ] 3 = Severely decomposed
- [ ] 4 = Dried carcass
- [ ] 5 = Skeleton, bones only

FINAL DISPOSITION: (check)
- [ ] 1 = Left on beach where found; painted? [ ] Yes* [ ] No(5)
- [x] 2 = Buried: [x] on beach / [ ] off beach; carcass painted before buried? [ ] Yes* [ ] No
- [ ] 3 = Salvaged: [ ] all / [ ] part(s), what/why?
- [ ] 4 = Pulled up on beach/dune; painted? [ ] Yes* [ ] No
- [ ] = Alive, released
- [ ] = Alive, taken to rehab. facility, where?
- [ ] 8 = Left floating, not recovered; painted? [ ] Yes* [ ] No
- [ ] 9 = Disposition unknown, explain

**If painted, what color?*

SEX:
- [x] Undetermined
- [ ] Female [ ] Male

Does tail extend beyond carapace?
- [ ] Yes; how far? ___ cm / in
- [x] No

How was sex determined?
- [ ] Necropsy
- [ ] Tail length (adult only)

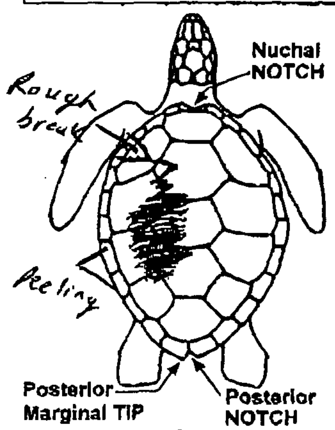
TAGS: ***Contact coordinator before disposing of any tagged animal!!***
Checked for flipper tags? [x] Yes [ ] No
Check all 4 flippers. If found, record tag number(s) / tag location / return address

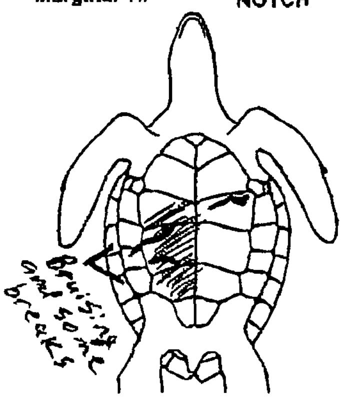
PIT tag scan? [x] Yes [ ] No
If found, record number / tag location

Coded wire tag scan? [ ] Yes [x] No
If positive response, record location (flipper)
Unable to check for
Checked for living tag? [x] Yes [ ] No
If found, record location (scute number & side)

CARAPACE MEASUREMENTS: (*see drawing*)

Using calipers		**Circle unit**
Straight length (NOTCH-TIP)	28.5	(cm) / in
Minimum length (NOTCH-NOTCH)		cm / in
Straight width (Widest Point)	26	(cm) / in
Using non-metal measuring tape		**Circle unit**
Curved length (NOTCH–TIP)		cm / in
Minimum length (NOTCH-NOTCH)		cm / in
Curved width (Widest Point)		cm / in
		Circle unit
Weight [x] actual / [ ] est.	7.2	kg / (lb)





Mark wounds / abnormalities on diagrams at left and describe below (note tar or oil, gear or debris entanglement, propeller damage, epibiota, papillomas, emaciation, etc.). **Please note if no wounds / abnormalities are found.**

Turtle was found dead impinged on grate. It was moderately decomposed. Carapace and plastron show evidence of being crushed. (Possibly post mortem). Carapace has scutes peeling off of the left side. Stomach and intestines were full. Contents included crab claws and crab parts. Organs were discolored and becoming liquidy due to normal decomposition. Buried at the north end of Brigantine on the beach.

OYSTER CREEK GENERATING STATION

Sea Turtle Incidental Take Report 2006-5

At approximately 0507 hours on Tuesday August 1, 2006, an Oyster Creek Generating Station (OCGS) operator performing a routine cleaning of the trash racks noticed a sea turtle under the water within Bay # 1 of the circulating water intake structure. The turtle appeared to be alert, healthy and moving about normally. In accordance with OCGS procedures, operators retrieved the sea turtle as gently as possible using a custom-designed dip net and lift net. OCGS Environmental personnel who took custody of the turtle confirmed it to be an adult loggerhead sea turtle (Caretta caretta). The water temperature at the time of the incidental take was approximately 85.0 F (29.4 C) and OCGS was in operation at 100% power with four circulating water pumps and two dilution pumps in operation. Although it is impossible to say precisely how long the turtle had been on the trash bars prior to removal, the dilution water trash racks had been inspected and cleaned earlier the same morning. The turtle was not observed during that trash rack inspection and cleaning.

The turtle measured only 29.1 in (74.0 cm) carapace length straight line and weighed 111 lb (50.4 kg). There was no sign of wounds or bruising on the turtle. There were numerous barnacles encrusting its carapace. No tags were present on the turtle when captured. USNRC and NMFS personnel were notified of the incidental take within 24 hours.

The turtle was taken to the Marine Mammal Stranding Center (MMSC) in Brigantine, NJ later the same morning that the incidental take occurred. At the MMSC, the turtle was examined, measured, fed and held for observation prior to release. After confirming that the turtle was feeding well on its own and diving normally, MMSC personnel tagged and released the turtle into the Atlantic Ocean at Brigantine, NJ on August 2, 2006.

SEA TURTLE STRANDING AND SALVAGE NETWORK – STRANDING RE]RT

OBSERVER'S NAME / ADDRESS / PHONE:
First ___Jay___ M.I.___ Last ___Pagel___
Affiliation _Marine Mammal Stranding Center_
Address _PO Box 773, 3625 Brigantine Blvd., Brigantine, NJ 08203_

Area code/Phone number _(609) 266-0538_

STRANDING DATE:
Year 20_06_ Month _08_ Day _01_
Turtle number by day _01_
Field ID # _MMSC-06-093_
Coordinator must be notified within 24 ; this was done by [x] ***phone (609)266-0538*** [ ] ***email*** [ ] ***fax***

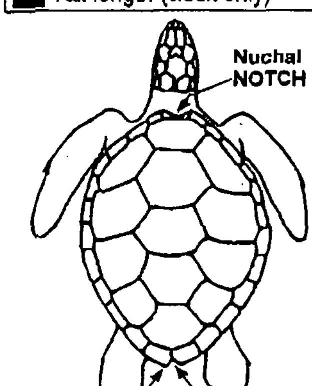
SPECIES: (check one)
- [x] CC = Loggerhead
- [ ] CM = Green
- [ ] DC = Leatherback
- [ ] EI = Hawksbill
- [ ] LK = Kemp's Ridley
- [ ] LO = Olive Ridley
- [ ] UN = Unidentified

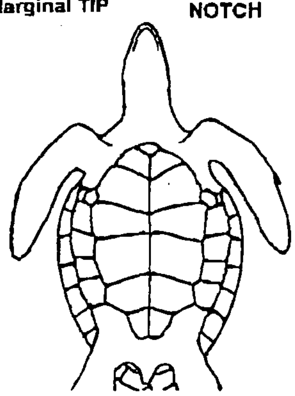
Check Unidentified if not positive. Do Not Guess.

Carcass necropsied? [ ] Yes [x] No
Photos taken? [x] Yes [ ] No
Species verified by coordinator? [x] Yes [ ] No

SEX:
- [ ] Undetermined
- [x] Female [ ] Male

Does tail extend beyond carapace? [ ] Yes; how far? ____ cm / in [x] No
How was sex determined? [ ] Necropsy [x] Tail length (adult only)





STRANDING LOCATION: [ ] Offshore (Atlantic or Gulf beach) [x] Inshore (bay, river, sounc et, etc)
State _New Jersey_ County _Ocean County_
Descriptive location (be specific) _Forked River, Oyster Creek Nuclear Power Plant, Impinged on grate_

Latitude _39.81417°N_ Longitude _74.20700°W_

CONDITION: (check one)
- [x] 0 = Alive
- [ ] 1 = Fresh dead
- [ ] 2 = Moderately decomposed
- [ ] 3 = Severely decomposed
- [ ] 4 = Dried carcass
- [ ] 5 = Skeleton, bones only

TAGS: *Contact coordinator before disposing of any tagged animal!!*
Checked for flipper tags? [x] Yes [ ] No
Check all 4 flippers. If found, record tag number(s) / tag location / return address

PIT tag scan? [x] Yes [ ] No
If found, record number / tag location

Coded wire tag scan? [ ] Yes [x] No
If positive response, record location (flipper)

Checked for living tag? [x] Yes [ ] No
If found, record location (scute number & side)

FINAL DISPOSITION: (check)
- [ ] 1 = Left on beach where found; painted? [ ] Ye]No(5)
- [ ] 2 = Buried: [ ] on beach / [ ] off beach; carcass painted before buried? [ ] Yes* [ ])
- [ ] 3 = Salvaged: [ ] all / [ ] part(s), what/why? _
- [ ] 4 = Pulled up on beach/dune; painted? [ ] Yes' |No
- [x] = Alive, released
- [x] 7 = Alive, taken to rehab. facility, where? _MI
- [ ] 8 = Left floating, not recovered; painted? [ ] Ye]No
- [ ] 9 = Disposition unknown, explain

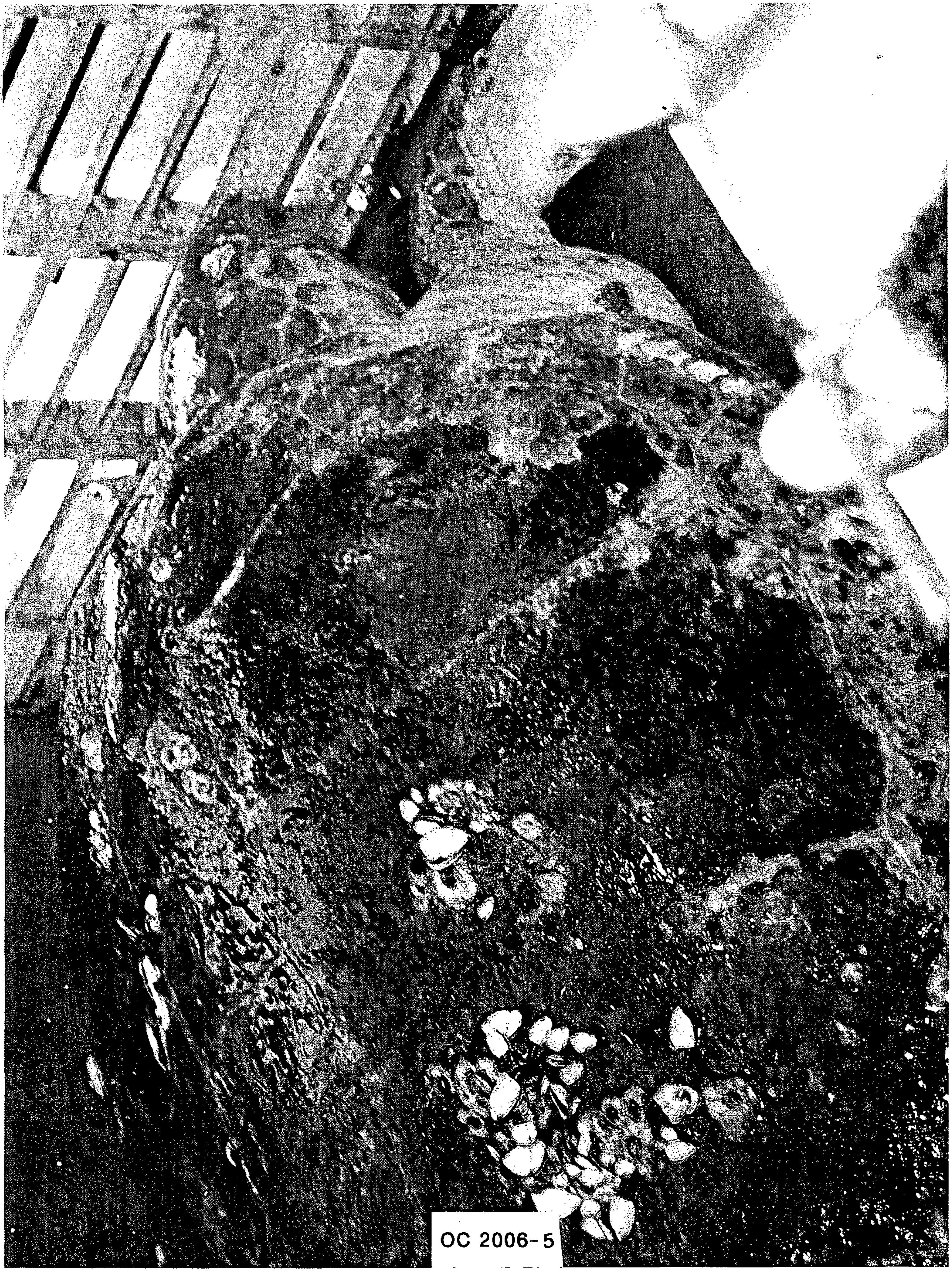
If painted, what color? ____

CARAPACE MEASUREMENTS: *(see dr ing)*

Using calipers	C e unit
Straight length (NOTCH-TIP)	74 / in
Minimum length (NOTCH-NOTCH)	m / in
Straight width (Widest Point)	65 est. n / in
Using non-metal measuring tape	**C. : unit**
Curved length (NOTCH–TIP)	n / in
Minimum length (NOTCH-NOTCH)	m / in
Curved width (Widest Point)	m / in
	Ci unit
Weight [x] actual / [ ] est.	111 /lb

Mark wounds / abnormalities on diagrams at left and describe below (note tar or oil, ar or debris entanglement, propeller damage, epibiota, papillomas, emaciation, etc.). I ase **note if no wounds / abnormalities are found.**

Turtle was taken to MMSC for observation after being impinged on gra . It was alert and responsive during transport and at the center. Slight curv on of the spine. There were a small amount of barnacles, gooseneck barn es, and leaches on carapace. He was observed for a day; eating well on ow and diving with out difficulty; pit tagged LFF with bar code: 4361077D68 anc metal tagged RFF #SSL117; released 08/02/2006 at 38th Street and b ch Brigantine, NJ Lat: 39.38917 °N Long: 74.38667°W 4361077D


OC 2006-5

Oyster Creek

AmerGen

An Exelon Company

AmerGen Energy Company
Oyster Creek
US Route 9 South, P.O. Box 388
Forked River, NJ 08731-0388

www.exeloncorp.com

October 30, 2006

2130-06-20416
2120-062-2993

RECEIVED NOV 13 2006

US Nuclear Regulatory Commission
Document Control Desk - NRC
Washington, DC 20555

Subject: Oyster Creek Generating Station
Docket 50-219
Sea Turtle Incidental Take Report 2006-6

This report provides detailed information regarding the recent incidental take of a juvenile Kemp's ridley sea turtle at the Oyster Creek Generating Station. The turtle was taken alive on 6 October 2006 from the dilution water intake structure trash bars. As indicated on the attached incident report, the turtle was promptly turned over to the custody of the Marine Mammal Stranding Center (MMSC) in Brigantine, NJ for examination and subsequent treatment of a pre-existing injury. The turtle was then taken to the Karen Beasley Sea Turtle Rescue and Rehabilitation Center in Topsail Island, NC for further treatment. The turtle is expected to be released to the Atlantic Ocean near the Karen Beasley Center personnel following a period of rehabilitation.

If you have any questions or require additional information, please do not hesitate to contact Mr. Malcolm Browne at (609) 971-4124.

Very truly yours,

Timothy S. Rausch
Vice President, Oyster Creek Generating Station

Enclosures
cc: Julie Crocker
U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Marine Fisheries Service Northeast Region
Protected Resources Division
One Blackburn Drive
Gloucester, MA 01930

cc: Pasquale Scida
U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Marine Fisheries Service Northeast Region
Protected Resources Division
One Blackburn Drive
Gloucester, MA 01930

Samuel J. Collins, Administrator, Region 1
US Nuclear Regulatory Commission
475 Allendale Road
King of Prussia, PA 19406

Edward G. Miller
Senior Project Manager
US Nuclear Regulatory Commission
Mail Stop 8-B1
Washington, DC 20555

Marc Ferdas
Senior Resident Inspector
Oyster Creek Generating Station
PO Box 388
Forked River, NJ 08731

Jeanette Bowers-Altman
NJ Department of Environmental Protection
Division of Fish, Game, and Wildlife
P.O. Box 400
Trenton, NJ 08625-0400

Regulatory Assurance File No. 06024

OYSTER CREEK GENERATING STATION

Sea Turtle Incidental Take Report 2006-6

At approximately 0940 hours on Friday October 6, 2006, an Oyster Creek Generating Station (OCGS) operator noticed a live sea turtle among the materials being removed from the trash racks while performing a routine trash rack cleaning of Bay # 6 of the dilution water intake structure. The turtle appeared to be healthy and moving about normally. OCGS Environmental personnel who took custody of the turtle confirmed it to be a juvenile Kemp's ridley sea turtle (Lepidochelys kempi). The water temperature at the time of the incidental take was approximately 65.8 F (18.8 C) and OCGS was in operation at 92.5 % power with four circulating water pumps and two dilution pumps in operation. Although it is impossible to say precisely how long the turtle had been on the trash bars prior to removal, the dilution water trash racks had been inspected and cleaned earlier the same morning. The turtle was not observed during that trash rack inspection and cleaning.

The turtle measured only 9.9 in (25.1 cm) carapace length straight line and weighed 3.5 lb (1.6 kg). Due to a pre-existing injury, almost the entire right front flipper was missing except for a short section covered with scar tissue. No tags were present on the turtle when captured. USNRC and NMFS personnel were notified of the incidental take within 24 hours.

The turtle was taken to the Marine Mammal Stranding Center (MMSC) in Brigantine, NJ at approximately 1100 hours on October 6, 2006. At the MMSC, the turtle was examined, measured, fed and held for observation prior to release. Because the outer scar tissue on the turtle's right front flipper had developed a small open wound during its attempts to free itself, MMSC personnel determined that the turtle would be transferred to the Karen Beasley Sea Turtle Rescue and Rehabilitation Center in Topsail Island, NC for further treatment. It is anticipated that following medical treatment at the Beasley Center, the turtle will be released into the nearby Atlantic Ocean.

cc: Pasquale Scida
U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Marine Fisheries Service Northeast Region
Protected Resources Division
One Blackburn Drive
Gloucester, MA 01930

Samuel J. Collins, Administrator, Region 1
US Nuclear Regulatory Commission
475 Allendale Road
King of Prussia, PA 19406

Edward G. Miller
Senior Project Manager
US Nuclear Regulatory Commission
Mail Stop 8-B1
Washington, DC 20555

Marc Ferdas
Senior Resident Inspector
Oyster Creek Generating Station
PO Box 388
Forked River, NJ 08731

Jeanette Bowers-Altman
NJ Department of Environmental Protection
Division of Fish, Game, and Wildlife
P.O. Box 400
Trenton, NJ 08625-0400

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OYSTER CREEK GENERATING STATION

Sea Turtle Incidental Take Report 2006-6

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The turtle measured only 9.9 in (25.1 cm) carapace length straight line and weighed 3.5 lb (1.6 kg). Due to a pre-existing injury, almost the entire right front flipper was missing except for a short section covered with scar tissue. No tags were present on the turtle when captured. USNRC and NMFS personnel were notified of the incidental take within 24 hours.

The turtle was taken to the Marine Mammal Stranding Center (MMSC) in Brigantine, NJ at approximately 1100 hours on October 6, 2006. At the MMSC, the turtle was examined, measured, fed and held for observation prior to release. Because the outer scar tissue on the turtle's right front flipper had developed a small open wound during its attempts to free itself, MMSC personnel determined that the turtle would be transferred to the Karen Beasley Sea Turtle Rescue and Rehabilitation Center in Topsail Island, NC for further treatment. It is anticipated that following medical treatment at the Beasley Center, the turtle will be released into the nearby Atlantic Ocean.

TOTAL P.02

SEA TURTLE STRANDING AND SALVAGE NETWORK – STRANDING REPORT

OBSE ER'S NAME / ADDRESS / PHONE:
First _ ndi M.I.____ Last Biehl
Affiliati Marine Mammal Stranding Center
Addres PO Box 773, 3625 Brigantine Blvd., Brigantine, NJ 08203

Area c :/Phone number (609) 266-0538

STRANDING DATE:
Year 20 06 Month 10 Day 06
Turtle number by day 01
Field ID # MMSC-06-134
Coordinator must be notified within 24 hrs; this was done by ■ ***phone (609)266-0538*** □ ***email*** □ ***fax***

SPECI : (check one)
□ CC .oggerhead
□ CM Green
□ DC .eatherback
□ EI Hawksbill
■ LK emp's Ridley
□ LO Olive Ridley
□ UN Unidentified
Check dentified if not positiv Do Not Guess.

STRANDING LOCATION: □ Offshore (Atlantic or Gulf beach) ■ Inshore (bay, river, sound, inlet, etc)
State New Jersey County Ocean County
Descriptive location (be specific) Forked River, Oyster Creek Nuclear Power Plant
Impinged on grate
Latitude 39.81417 °N Longitude 74.20700 °W

Carcas cropsied? □ Yes ■ No
Photos en? ■ Yes □ No
Specie rified by coordinator?
■ Yes □ No

CONDITION: (check one)
■ 0 = Alive
□ 1 = Fresh dead
□ 2 = Moderately decomposed
□ 3 = Severely decomposed
□ 4 = Dried carcass
□ 5 = Skeleton, bones only

FINAL DISPOSITION: (check)
□ 1 = Left on beach where found; painted? □ Yes* □ No(5)
□ 2 = Buried: □ on beach / □ off beach; carcass painted before buried? □ Yes* □ No
□ 3 = Salvaged: □ all / □ part(s), what/why? ________
□ 4 = Pulled up on beach/dune; painted? □ Yes* □ No
□ 6 = Alive, released
■ 7 = Alive, taken to rehab. facility, where? Topsail Is., NC The Karen Beasley Sea Turtle Rescue and Rehabilitation Center
□ 8 = Left floating, not recovered; painted? □ Yes* □ No
□ 9 = Disposition unknown, explain ________
***If painted, what color?** ________

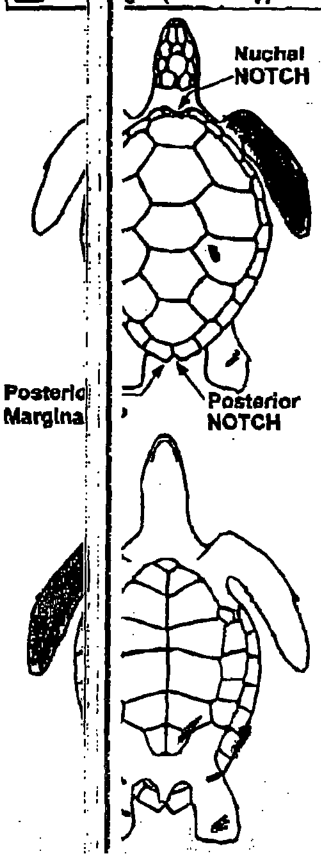
SEX:
■ Und rmined
□ Fer : □ Male
Does ta xtend beyond carapace?
□ Yes w far? ______ cm / in
□ No
How w ex determined?
□ Nec sy
□ Tail gth (adult only)

TAGS: *Contact coordinator before disposing of any tagged animal!!*
Checked for flipper tags? ■ Yes □ No
Check all 4 flippers. If found, record tag number(s) / tag location / return address

PIT tag scan? ■ Yes □ No
If found, record number / tag location

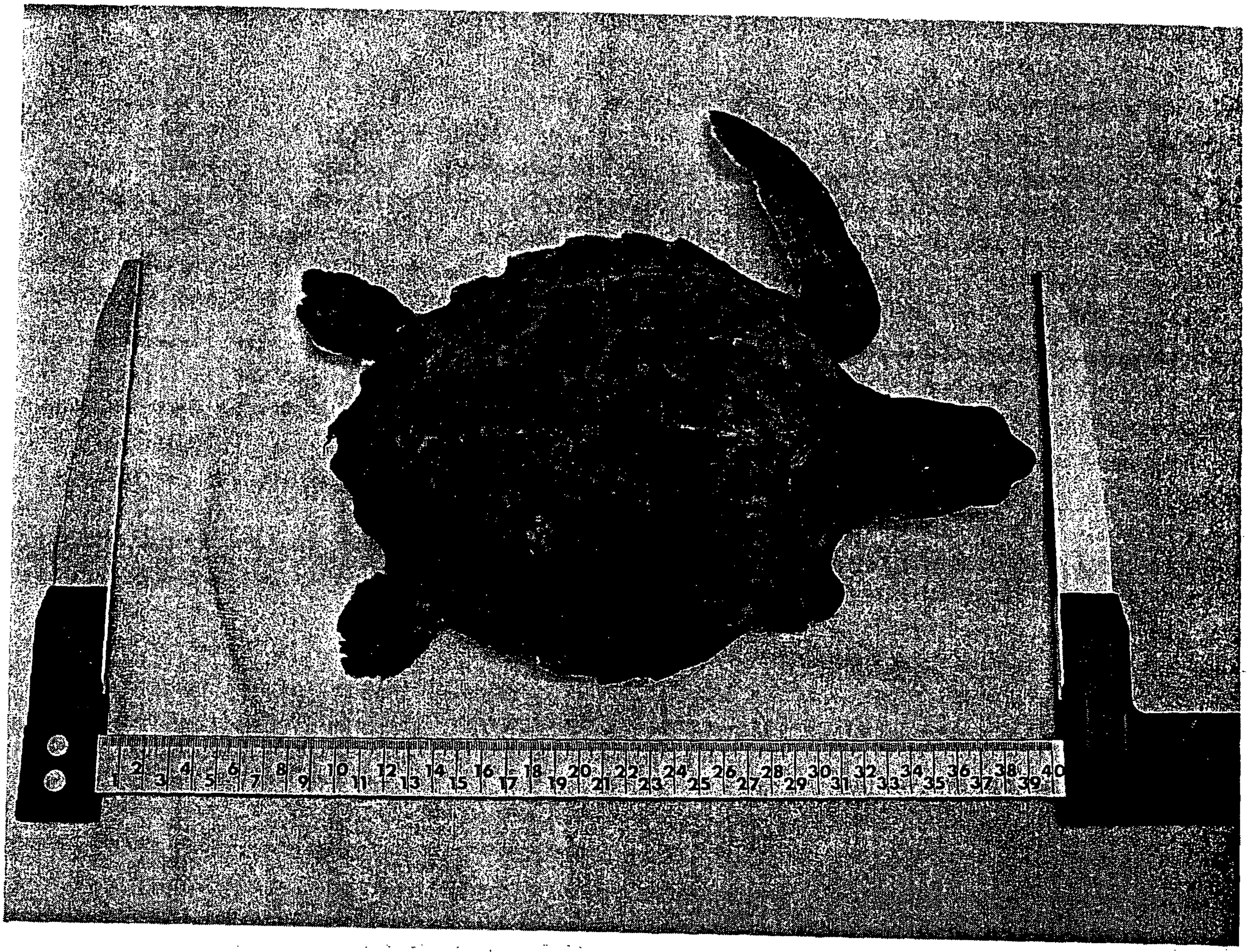
Coded wire tag scan? □ Yes ■ No
If positive response, record location (flipper)
Unable to check for
Checked for living tag? ■ Yes □ No
If found, record location (scute number & side)

CARAPACE MEASUREMENTS: *(see drawing)*
Using calipers — **Circle unit**
Straight length (NOTCH-TIP) 25.1 cm / in (cm circled)
Minimum length (NOTCH-NOTCH) ______ cm / in
Straight width (Widest Point) 19.6 cm / in (cm circled)
Using non-metal measuring tape — **Circle unit**
Curved length (NOTCH–TIP) ______ cm / in
Minimum length (NOTCH-NOTCH) ______ cm / in
Curved width (Widest Point) ______ cm / in
Circle unit
Weight ■ actual / □ est. 3.4 kg / lb (lb circled)



Mark wounds / abnormalities on diagrams at left and describe below (note tar or oil, gear or debris entanglement, propeller damage, epibiota, papillomas, emaciation, etc.). **Please note if no wounds / abnormalities are found.**

_ alive; bright, alert, responsive ; RFF has been cleanly severed just before the socket/joint connection; abrasions on all four flippers; RRF has 1/2 inch cut on ventral surface with healed area on dorsal surface; some scaring on plastron; taken to MMSC for treatment.
10-7-06 Transferred to Topsail Turtle Hospital - The Karen Beasley Sea Turtle Rescue and Rehabilitation Center for surgery and Rehabilitation


1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, Maryland 20910

NRC - Oyster Creek

SEP 21 1995

Dennis M. Crutchfield
Associate Director
for Advanced Reactors and License Renewal
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Dear Mr. Crutchfield:

Enclosed is the Biological Opinion regarding the Oyster Creek Nuclear Generating Station (OCNGS). This Biological Opinion concludes that continued operation of this plant may adversely affect listed sea turtles, but is not likely to jeopardize their continued existence.

The project area is not known to be a high-use area for turtles, and no sea turtles were observed at the OCNGS during the first 23 years of operation. Turtles were also not observed in station-related sampling surveys of the Forked River, Oyster Creek, or Barnegat Bay or in surveys conducted by the State of New Jersey. In addition, few turtle strandings have been recorded for Barnegat Bay and the associated inshore waterways over the last 10 years by the Northeast Sea Turtle Stranding and Salvage Network. However, since June 1992, 9 sea turtle impingements (including one recapture) have occurred at the cooling water intake trash racks.

This Biological Opinion sets the following Incidental Take Allowance: 10 per year with up to 3 mortalities for loggerhead turtles; 3 per year with up to 1 mortality for Kemp's ridley turtles; and 2 per year with up to 1 mortality for green turtles. This Incidental Take Allowance extends for a period of five years from the date of the attached biological opinion. ~~Reinitiation~~ Reassess of consultation is required if, during any one year, twelve turtles are taken and/or there is a lethal take of one Kemp's ridley OR one green turtle.

This Biological Opinion considers the Biological Assessment prepared by OCNGS and received by the National Marine Fisheries Service (NMFS) on January 25, 1995 as well as additional sources of new information. If you have any questions, please call Kim Thounhurst at (508) 281-9138 or Karen Salvini at (301) 713-1401.

Sincerely,

William W. Fox, Jr., Ph.D.
Director
Office of Protected Resources

Attachment

cc w/attachment: F/PR8 - Salvini, F/NEO2 - Beach, Mantzaris, Thounhurst, Wurst, David Jenkins (NJ Dept of Environmental Protection), Robert Schoelkopf (Marine Mammal Stranding Center)

ENDANGERED SPECIES ACT

SECTION 7 CONSULTATION

BIOLOGICAL OPINION

Agency:	Nuclear Regulatory Commission
Activity:	Consultation in accordance with Section 7(a) of the Endangered Species Act of 1973 (ESA) regarding continued operation of the Oyster Creek Nuclear Generating Station in the Forked River and Oyster Creek, Barnegat Bay, New Jersey.
Consultation Conducted By:	National Marine Fisheries Service Northeast Regional Office
Date Issued:	9-21-95

BACKGROUND:

The Oyster Creek Nuclear Generating Station (OCNGS) began commercial operation in 1969, prior to the authorization of the ESA. Therefore no consultation had been conducted in accordance with Section 7(a) of the ESA by the National Marine Fisheries Service (NMFS) with the Nuclear Regulatory Commission (NRC) on the operations of the OCNGS in the Forked River, Barnegat Bay, New Jersey. No observed takes of endangered species occurred at the OCNGS prior to 1992.

Though sea turtles are known to use New Jersey's coastal waters, no turtles were taken at the plant during the first 23 years of operation, and none were observed in Barnegat Bay in 20 years of sampling conducted by the OCNGS through 1992. Incidental captures of sea turtles at the OCNGS Circulating Water System (CWS) and Dilution Water System (DWS) cooling water intakes were documented (in June of 1992) by the OCNGS Environmental Controls personnel and reported to NMFS according to reporting procedures established through informal consultation conducted between the OCNGS, NRC, and NMFS.

Subsequent to the 1992 takes of sea turtles at the OCNGS, NMFS notified the OCNGS (in a letter dated September 14, 1992) that formal consultation under Section 7 of the ESA was necessary. Through further discussion under informal consultation, it was decided that formal consultation was not necessary at the time,

provided that certain mitigation measures (increased vigilance of plant personnel and awareness of reporting requirements, reporting of takes to NMFS and NRC, and transfer of turtles to the stranding network for rehabilitation and/or release) were implemented.

Between June 1992 and July 1994, 9 sea turtle impingements occurred at the OCNGS intake trash bars, including 5 loggerheads (4 individuals, 1 recapture), and 4 Kemp's ridleys. Two of the loggerheads and 3 of the Kemp's ridleys were recovered dead. Cause of death could not be determined in all cases.

In a letter dated November 2, 1993, NMFS stated that formal consultation was now necessary due to additional takes of threatened and endangered sea turtles. In a letter dated November 19, 1993, the NRC requested formal consultation. A Biological Assessment was prepared by the OCNGS, reviewed by the NRC, and received by NMFS on January 25, 1995.

PROPOSED ACTIVITIES:

The proposed activity is the continued operation of the Oyster Creek Nuclear Generating Station.

The Oyster Creek Nuclear Generating Station is located near the town of Forked River, midway between the south branch of the Forked River and Oyster Creek, New Jersey. The Forked River and Oyster Creek empty into Barnegat Bay. When the plant is operational, the flow direction in the south fork of the Forked River is reversed, and all of the flow goes into the OCNGS. The resultant warmed water is discharged via Oyster Creek into Barnegat Bay.

Water used to cool the condensers and associated systems is drawn into the OCNGS from the south fork of the Forked River through 6 intake bays at the Circulation Water System (CWS) and 6 intake bays at the Dilution Water System (DWS) when additional cooling is necessary. The intake at each bay is screened by trash racks, which extend from the bottom of each intake bay to several feet above the water. The average water depth is 18 feet.

The dimensions and structures at the CWS are nearly identical to those of the DWS. The major difference is that the intake velocity at the DWS is much higher and would therefore pose a greater threat to sea turtles than current velocity effects at the CWS. The intake velocity at the CWS is 0.56-0.66 ft/sec when all four pumps are operating and all six intake bays are open. By contrast, the intake velocity at the DWS is 2.4 ft/sec when both pumps are operating. The DWS is only operational in the summer and fall when temperatures are high enough to warrant

additional cooling in the condensers. This period coincides with the times when turtles are likely to use the area.

LISTED SPECIES LIKELY TO OCCUR IN THE PROJECT AREA:

Project activities are known to affect endangered Kemp's ridley sea turtles and threatened loggerhead sea turtles. Listed species under the jurisdiction of NMFS that may occur in Barnegat Bay and associated waterways and may be affected by the proposed activities include the following:

Threatened -

Loggerhead turtle (Caretta caretta)

> All continental shelf waters and large bays from Virginia to Massachusetts from June through November.

Endangered -

Green turtle (Chelonia mydas)

> Occasionally found in nearshore waters from Massachusetts to Virginia from June through October.

Kemp's ridley turtle (Lepidochelys kempii)

> Inshore bay and estuarine habitat -- north to Massachusetts from July through October.

ADDITIONAL BIOLOGY AND DISTRIBUTION OF THE SPECIES:

Loggerhead turtle (Caretta caretta)

The loggerhead turtle is the most abundant species of sea turtle occurring in U.S. waters. Aerial surveys indicate that loggerheads occur pelagically, but are most common in waters less than 50 meters in depth (Shoop, et. al. 1981; Fritts et. al. 1983). They are known to inhabit coastal areas as juveniles and adults, and often enter bays, lagoons, and estuaries (Ernst and Barbour 1972). Different theories exist on why juvenile sea turtles use northeastern U.S. waters, but it has been demonstrated that these areas are important developmental habitat for loggerheads, as well as other chelonid turtles (Morreale and Standora 1994).

Their primary food sources are benthic invertebrates including mollusks, crustaceans, and sponges (Mortimer 1982). Although they are known to eat fish, clams, oysters, sponges, and

jellyfish, the loggerhead's preferred prey in Atlantic embayments appear to be various species of crabs (Musick et. al. 1987, Morreale and Standora 1994). Stomach content analysis of stranded specimens in Massachusetts showed that crabs were the major component of the diet there as well, along with clams, quahogs, moon snails, and squid (Prescott 1982).

Loggerhead populations are under stress from human-induced sources such as boat strikes, pollution, marine habitat degradation, development of nesting beaches, and incidental captures in fishing gear, in addition to a number of natural causes. Crouse et. al. (1987) published information indicating that the stability of loggerhead populations may be more sensitive to changes in the status of juveniles than pressures on other developmental stages. Stranding data indicates that the majority of loggerheads found off the Northeast U.S. are juveniles. Cumulative stresses on the animals in this area, then, may be impeding the recovery of this population.

Green turtle (Chelonia mydas)

Green turtle populations in the U.S. are listed as endangered if they are from the Florida breeding population and threatened if they belong to other populations. NMFS/Northeast Region considers them to be endangered unless the natal beach of the turtle is known.

Green turtles are more tropical in distribution than loggerheads and are generally found in waters between the northern and southern 20°C isotherms (Hirth 1971). They are occasionally encountered in pound nets as far north as Long Island Sound in New York, and strandings have been reported as far north as Cape Cod Bay, Massachusetts (Prescott 1982).

A 38-cm green turtle captured, tagged, and released in New York was recaptured almost one year later only 13 km from the original capture site. This suggests that, during developmental stages, the turtles may return to the same productive areas of the northwest North Atlantic for several years before establishing residency as adults in more tropical seagrass beds (Morreale and Standora 1994).

Most of the green turtles reported in U.S. waters are immature (Thompson 1988). Adult green turtles do not migrate from their regular habitat except to visit the nesting beaches (Agardy, unpubl.). Green turtle nesting in the U.S. occurs mainly on the Atlantic coast of Florida (Ehrhart 1979). More extensive nesting occurs on more southerly beaches of the western Atlantic.

Adult green turtles are herbivorous, feeding mainly on sea grasses and algae (Cymodocea, Thelassia, Zostera, Sagittaria, and

Vallisneria) (Babcock 1937; Underwood 1951; Carr 1954, 1952; Neill 1958; Mexico 1966). Immature turtles go through an omnivorous stage (1-3 years) and may be feeding on different food items than the preferred vegetation consumed by adults (Morreale and Standora 1994). Known feeding habitats in the U.S. include shallow lagoons and embayments in Florida. Similar inshore feeding areas are believed to occur elsewhere along the Atlantic coast.

Green turtles are subject to the same threats mentioned above for loggerheads. Incidental catch in commercial fisheries has the largest impact, along with trade in the animals and their products.

Kemp's ridley turtle (Lepidochelys kempii)

The Kemp's ridley turtle is probably the most severely endangered species of sea turtle in the world. The population decline of this species is one of the most dramatic ever recorded (USFWS and NMFS 1992). The only major nesting beach for Kemp's ridleys is a single stretch of beach near Rancho Nuevo, Tamaulipas, Mexico (Carr 1963, Hildebrand 1963). Virtually the entire world population of adult females nests annually in this single location (Pritchard 1969). The total number of adults in 1988 was estimated to be 1,580 to 1,750 individuals (Marquez, 1990).

While adult Kemp's ridleys may occur almost exclusively in the Gulf of Mexico, a significant number of hatchlings may be transported north along the Atlantic coast of the U.S. Kemp's ridleys have been caught offshore in commercial fishing gear as far north as northeast Georges Bank, Massachusetts (Parsons, pers. comm.). Pritchard and Marquez (1973) speculate that these young turtles feed and grow rapidly during passive transport until they are large enough to actively swim into embayments as far north as New England. These embayments apparently serve as important foraging habitats for single year classes of Kemp's ridleys. Morreale et. al. (1989) reported increases in weight of over 500 grams per month for juvenile Kemp's ridleys tracked in the Long Island Sound. As with the loggerhead turtle, juvenile Kemp's ridleys use northeastern waters as developmental habitat, foraging throughout the summer until decreasing temperatures send them south in the fall (Morreale and Standora 1994).

Reported prey of Kemp's ridleys includes benthic crustaceans such as Polyonchus, Hepatus, Callinectes, Panopeus, Ovalipes, Calappa, Portunas, Araneus), fish (Lutjanus, Leiostomus), and mollusks (Noculana, Corbula, Mulinia, Nassarius) (Dobie, et. al. 1961; Pritchard and Marquez 1973). All of these genera are common along the eastern coast of the United States. Morreale and Standora (1992) determined that Kemp's ridleys feed primarily on crabs in New York waters. Analysis of stomach contents of

Kemp's ridleys stranded in Cape Cod Bay, Massachusetts, indicated that they are feeding on fish, sand dollars, bay scallops, and blue mussels in those waters (Prescott 1982).

From tracking studies, Morreale and Standora (1994) determined that Kemp's ridleys are sub-surface animals that frequently swim to the bottom while diving. The generalized dive profile showed that the turtles spend 56% of their time in the upper third of the water column, 12% in mid-water, and 32% on the bottom. In water shallower than 15 m (50 ft), the turtles dive to depth, but spend a considerable portion of their time in the upper portion of the water column. In contrast, turtles in deeper water dive to depth, spending as much as 50% of the dive on the bottom.

Evidence presented in Crouse et. al. (1987) illustrating the importance of juveniles to the stability of loggerhead populations may have important implications for Kemp's ridleys as well. The vast majority of Kemp's ridley occurrences along the Atlantic Coast of the U.S., largely identified from strandings, have been juveniles. Sources of mortality in this area include boat strikes, pollution, marine habitat degradation, and incidental captures in fishing gear, as well as a number of natural causes. Therefore, loss of animals in the Atlantic may be impeding the recovery of this population.

ASSESSMENT OF IMPACTS:

This assessment is based on a review of the Biological Assessment (BA) prepared by OCNGS Environmental Affairs, pertinent information submitted by the OCNGS, and other biological information referred to in Appendices.

The two major threats to sea turtles at the OCNGS are impingement at the cooling water intakes and possible cold stunning. Turtles may be attracted to the thermal effluent from the discharge canal that warms Oyster Creek, and could be cold-stunned when leaving the creek and returning to the colder water in Barnegat Bay in the late fall.

Impingements of Sea Turtles

Most sea turtles likely to occur in the project area are large enough that they would not pass through the intake screens, which are constructed with 2.6-inch wide openings. The BA states that any small turtles that would pass through the CWS intake trash bars would be transported safely and returned to the water via the same system that returns entrained fish and other small organisms. The DWS intake trash bars are not equipped with travelling screens to return entrained organisms to the water. It is unlikely that hatchling sea turtles would be in the area,

although at least one nest has been documented for New Jersey by the Sea Turtle Stranding and Salvage Network (STSSN)(Schoelkopf, pers. comm.).

Little information exists about the swimming behavior of turtles which can be used to make predictions about behavior at intake gratings or the ability to swim against various current velocities. One of the turtles which was eventually impinged was first sighted apparently trying to swim away from the intake bay, but being pulled back. The ability of a given turtle to swim against the current at either the CWS or DWS intake would depend on the species, size, and relative health of each individual. A turtle weakened by disease or injured by a boat strike would be more susceptible to impingement if the velocity at the intake is a factor in the likelihood of impingement. In addition, sea turtles are known to be less active at night, so there may be increased likelihood of impingement at night.

There is no information on the relative effects of suction at the trash racks on a turtle-shaped object for different current velocities. It may be much more difficult for a turtle to remove itself from a position parallel to the trash rack than from a perpendicular position at the surface.

A turtle that swims or drifts on the surface toward the OCNGS intakes may be turned away by the floating wooden debris/ice barrier. It is unclear, however, that this is an effective barrier to live turtles, since there are gaps on either end which a turtle could easily swim through. Since the barrier only extends 2 feet below the surface, a healthy turtle could easily swim under as well. The purpose for the barrier is to divert floating debris away from the CWS toward the DWS. The orientation of the barrier may result in turtles at the surface being funneled toward the DWS when that system is operating.

Debris is cleaned from the intake screens by a trash rake which is moved on a track from one bay to the next. The rake, a horizontal array of large curved tines, is lowered down into the bay to remove debris from the intake gratings. When the rake reaches the desired depth, the tines are deployed, curving downward to penetrate through the grate before the rake is raised. This process could cause serious injury to a turtle.

Debris floating on the surface could make it more difficult to spot a turtle below, particularly if the turtle was flush against the grating. A small amount of debris may not be enough to block the flow and necessitate use of trash rakes, but could hide a turtle. In addition, visibility at the intake bays, which are 15 (DWS) to 18 (CWS) feet deep, is only 2-3 feet. Although at least one of the impinged turtles was found alive with its head out of water, a turtle that is impinged at depth could remain out of sight until the trash rake was lowered to it. Detailed

information regarding behavior and orientation of each turtle when impinged and when discovered has not been collected for each of the impingements at the OCNGS. It is possible that a turtle could swim into the intake bay, encounter the grating, and swim down along the grating to a depth below the view of surface observers. If a turtle is feeding on the bottom of the intake canal, its first encounter with the intake grating could be at depth.

It is possible that a turtle could be caught up against the grate underwater by the current long enough to cause suffocation. Plant personnel estimated that the turtles that were taken had been impinged for up to 8 hours. In some natural situations, turtles may remain submerged for several hours. However, stress dramatically decreases the amount of time a turtle can stay submerged. For example, trawl times for shrimpers in the southeast are limited by regulation to 55 minutes in the summer months and 75 minutes in the winter months, due to the fact that turtles are known to suffocate in shrimp trawls in very short time periods. Additionally, turtles may suffocate more readily in the summer months due to higher body temperature and metabolism. Other factors, such as the activity of the turtle and whether or not it has food in its stomach, may also affect the length of time it may stay submerged.

Previous Impingements at Oyster Creek Nuclear Generating Station

There have been 9 incidental captures of sea turtles associated with operations at the OCNGS (4 at the CWS intake trash bars and 5 at the DWS intake trash bars) between September 9, 1992, and June 19, 1994 (Table 1). These include 4 Kemp's ridley captures and 5 (4 individuals, 1 recapture) loggerhead captures.

Operation of the OCNGS has not changed appreciably since 1969, suggesting that the onset of turtle captures is due to higher numbers of sea turtles in the project area, or lack of knowledge of the impacted turtles.

The diversion of the south fork of the Forked River may have created conditions which attract turtles and therefore increase the likelihood of impingement. When the plant is operational, all flow in the south fork is diverted into the cooling water intakes, so it is possible that impingements of turtles at the OCNGS could be the result of routing the entire south fork rather than of an attraction at the intake screens. (The diversion also represents a reversal of flow in the south fork.) The possibility that the OCNGS is attracting or diverting turtles into the plant is sufficient enough that turtles that may have died before impingement should be included in the assessment of take, unless the cause of death is readily visible (such as a traumatic propeller injury) or is revealed through necropsy. Due

to the tentative nature of existing population estimates, comparison of incidental take numbers to total population sizes is not possible.

Size documentation of sea turtles taken by impingement at the OCNGS indicate that all of the sea turtles were juveniles. Identification of the sex of immature turtles is very difficult without the training of a qualified herpetologist. Misidentification of the sex of juvenile turtles is a chronic problem, since undifferentiated gonads are easily confused with ovaries. The only dead turtle from OCNGS for which sex was identified was reported as a female. Accurate identification of the sex of dead sea turtles should be ascertained.

Kemp's ridleys

Four Kemp's ridleys were reported impinged at the OCNGS intake trash bars between 1992 and 1994. Annual takes ranged from 1 to 2 Kemp's ridleys. Three of these turtles were recovered dead, with an average of 1.0 observed mortalities per year (range 0 to 2) observed in association with the OCNGS intake structures. Necropsy reports are not available for all the Kemp's ridley mortalities, so it is not possible to adjust this rate to reflect mortalities which may have occurred prior to impingement. Therefore the lethal take rate for Kemp's ridleys at the OCNGS is 1.0 turtles per year.

Loggerheads

A total of 5 loggerhead impingements occurred at the OCNGS intake trash bars between 1992 and 1994, with an average of 1.7 takes per year. Annual takes ranged from 0 to 3 (including one recapture) loggerheads. Two of these turtles were recovered dead, with an average of 0.7 observed mortalities per year (range 0 to 1) observed in association with the OCNGS intake structures. Necropsy reports are not available for all the loggerhead mortalities, so it is not possible to adjust this rate to reflect mortalities which may have occurred prior to impingement. Therefore the lethal take rate for loggerheads at the OCNGS is 0.7 turtles per year.

Cold Stunning

Existing data from OCNGS and other power plants in the NMFS/Northeast Region does 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. Cold-stunning, the comatose condition of sea turtles subjected to water temperatures lower than 8°C, is common in Atlantic

embayments (Meylan 1986; Ehrhart 1983). Data reported by the STSSN indicate that cold-stunning occurs around mid-November in New York waters. No incidental captures of sea turtles have been reported at the OCNGS later than October, suggesting that sea turtles may leave this site before cold-stunning would occur.

The thermal effluent discharged from the plant into Oyster Creek may represent an attraction for turtles. If turtles are attracted into Oyster Creek by this thermal plume, they could remain there late enough in the fall to become cold-stunned when they finally travel into Barnegat Bay. As stated in the BA, however, it may be unattractive for turtles to fight the current (2.1-3.1 ft/sec) long enough to remain in the warmest portions of the effluent. Although blue crab and horseshoe crab are found in the canal, it is unlikely that much forage is available during the colder months. Dr. Stephen Morreale noted, in the report of the necropsy performed on the Kemp's ridley impinged on October 17, 1993, that turtles may not be feeding at this time of the year due to a behavioral shift.

Other Habitat Considerations

Turtles could be attracted to the intake screens when prey items such as blue crabs and horseshoe crabs are gathered there. One loggerhead turtle was recaptured 2 days after it was released into the discharge canal. This suggests that the turtle was attracted either to the ambient conditions in the south fork of the Forked River or to the conditions at the intake trash racks.

Information on stomach contents of incidentally captured sea turtles recovered at the OCNGS is only available for two specimens at this time. One was impinged on October 17, 1993, and found to have no stomach contents, but this finding was attributed to the time of the year, when feeding is not expected. The other impingement occurred July 6, 1994, and the presence of blue crabs in both the esophagus and stomach suggest that this turtle was actively feeding prior to death. No quantitative diet study has been conducted and species listed on necropsy reports typically include only those most easily identified.

Attractive features may be associated with the discharge as well as the intake. The warm water discharge may increase the distribution of prey species to the area, and returns of live entrained organisms or dead fish and other material dumped from the trash racks may provide food for the turtles or scavenging prey species.

There have been changes in the hydrology of Barnegat Bay as well as changes in sea turtle distribution over the past ten years. There is a lack of information about the impact of these changes on the likelihood of impingement of turtles at OCNGS. If

maintenance dredging, which increases water volume, makes the bay more accessible to turtles, the frequency of impingements at OCNGS may increase after each dredging episode and decrease as the bay fills with sediment, suggesting a causal relationship. There is little information on food resources in the bay and no information on how turtles use the bay. If turtle populations recover appreciably, the rate of impingement at OCNGS may reflect a corresponding increase.

Environmental Sampling and Stranding Information

No turtles have been sighted in biological sampling efforts conducted by or for the OCNGS. However, the BA does not state time of year, specific locations, or what portions of the water column were sampled. Added to the fact that we do not know enough about how turtles use the bay, it is not possible to determine whether the sampling was representative of the time when turtles were likely to be in the area, or whether sampling efforts tracked the potential high-use areas and the appropriate portion of the water column.

Approximately 16,500 hours of impingement sampling (24-54 hours/week) was conducted by OCNGS from 1975-1985, with no turtles sighted. Trawl sampling and seine sampling, which consisted of roughly 3000 samples from 1975-1981, also resulted in no turtle captures. The BA does list one reference of a loggerhead caught in an otter trawl during a 5-year survey of Great Bay and Little Egg Harbor conducted by Rutgers University (K. Able, Tuckerton Marine Research Facility).

Any takes that occur during station-related sampling by OCNGS will be considered and included within the incidental take statement. It is not anticipated that biological sampling will result in lethal take.

Stranding data for the New Jersey coast in Ocean County suggests that the majority of strandings occur on the ocean side of the barrier beaches, not in the inshore areas (STSSN data reported by the Marine Mammal Stranding Center, Brigantine, New Jersey). The 1985-1994 data for Ocean County show that only 14% (n=12) of the 88 strandings for that time period occurred in inshore waters. Eleven of those 12 were in Barnegat Bay and associated waterways in Ocean County. One stranding which occurred just outside the north end of Barnegat Inlet was an animal which may have been feeding in the bay, struck by a boat, and then washed out through the Inlet. The data for the past 10 years shows 9 other strandings clumped in that same area, suggesting that strandings of dead animals with propeller scars in that area may be indicative of additional animals which are using Barnegat Bay.

CUMULATIVE EFFECTS:

Cumulative impacts from unrelated, non-federal actions occurring in Barnegat Bay may affect protected species and their habitats. The Marine Mammal Stranding Center in Brigantine, New Jersey, reports an increase in the number of turtles hit by boats in New Jersey inshore waters. STSSN data show that turtles found in other northeast embayments die of various natural causes, including cold stunning, and from human activities, such as boat hits, degradation of nesting habitat, incidental captures in fishing gear, and ingestion of or entanglement in debris. However, the cause of death of most turtles recovered by the STSSN is unknown.

CONCLUSION:

Based upon a review of the information available on the biology and ecology of the endangered and threatened species in the North Atlantic affected by the continued operation of the Oyster Creek NGS, NMFS concludes that the continued operation of this station may adversely affect, but is not likely to jeopardize the continued existence of the species listed above or result in destruction or adverse modification of their habitat. The following factors form the basis for this conclusion:

1. The maximum number of observed lethal takes, documented annually since 1992, is two Kemp's ridleys (average = 1.0 per year) and one loggerhead (average = 0.7). The mortality of any Kemp's ridley is significant but mortalities of less than two juvenile ridleys per year is conservative and consistent with takes allowed in similar operations.

2. The continued operation of the Oyster Creek NGS at the existing level is not expected to change the observed mortality levels.

3. Increased monitoring of the intake screens and consistent use of resuscitation techniques may decrease the observed mortality level.

REINITIATION OF CONSULTATION:

Reinitiation of formal consultation is required if: (1) the amount or extent of taking specified in the incidental take statement (Attachment 1) is exceeded, (2) new information reveals effects of the action that may affect listed species or critical habitat (when designated) in a manner or to an extent not previously considered, (3) the identified action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in the Biological

Opinion, or (4) a new species is listed or critical habitat designated that may be affected by the identified action.

The Incidental Take Allowance extends for a period of five years from the date of this biological opinion. Reinitiation of consultation is required if, during any one year, twelve turtles are taken and/or there is a lethal take of one Kemp's ridley OR one green turtle.

CONSERVATION RECOMMENDATIONS:

The following conservation recommendations are suggested:

1. In conjunction with NMFS, develop a research program to determine whether the plant provides features attractive to sea turtles. This program should investigate habitat use, diet, and local and long-term movements. Use of existing mark/recapture and telemetry methods should be considered in Barnegat Bay and associated waterways.

2. Conduct underwater viewing or diving behavior telemetry studies of turtles at the intake bays, in the Forked River, in the Oyster Creek discharge canal, and in Barnegat Bay to determine how turtles use these waterways and their behavior in the intake bays.

3. Conduct distribution surveys for sea turtles in Barnegat Bay, Forked River, and Oyster Creek. Data recorded should include time of year, specific locations, and portions of the water column sampled.

4. Historical benthic survey data should be reviewed to identify prey density and distribution at various sites in the project area and associated waterways and clarify the potential for attractions of invertebrates to this site during times when turtles are likely to be in the area.

5. Meet with NMFS annually to review incidental takes, assess the status of sea turtles in the project area and associated waterways, and to reconsider these recommendations accordingly.

INCIDENTAL TAKE STATEMENT:

Section 7(b)(4) of the ESA requires that when an agency action is found to comply with Section 7(a)(2), NMFS will issue a statement specifying the impact of incidental taking of endangered species, provide reasonable and prudent measures necessary to minimize impacts, and set forth the terms and conditions with which the action agency must comply to implement the reasonable and prudent measures.

The significance of each Kemp's ridley turtle mortality is considered in determining an allowable incidental take. Therefore, we have established a take level of 3 Kemp's ridleys per year with 1 mortality, 2 green turtles per year with 1 mortality and 10 loggerheads per year with up to 3 mortalities. This take level is allowed provided the following reasonable and prudent measures necessary to minimize the impact on listed species are met through the terms and conditions stated below:

1. The new protocol for inspection of CWS and DWS cooling water intake trash bars (and immediate area upstream) at least once every 4 hours (twice per 8-hour shift) must be continued and implemented from June 1 through October 31.

Inspections are to follow a set schedule so that they are regularly spaced rather than clumped. The proposed schedule of 1-2 hours into each 8-hour shift and 5-6 hours into each 8-hour shift should be followed. Times of inspections, including those when no turtles were sighted, must be recorded.

2. An attempt to resuscitate comatose sea turtles must be made according to the procedures described in Appendix I. These procedures should be posted in appropriate areas such as the intake bay areas for both the CWS and the DWS, any other area where turtles would be moved for resuscitation, and the CWS and DWS operator's office(s).

3. Dip nets, baskets, and other equipment are to be available at both the CWS and the DWS and are to be used to remove smaller sea turtles from the OCNGS intake structures to reduce trauma caused by the existing cleaning mechanism.

4. The Oyster Creek Nuclear Generating Station's CWS and DWS (when operational) intake trash bars must be cleaned daily from June 1 to October 31.

a. Cleaning must include the full length of the trash rack, i.e., down to the bottom of each intake bay. To lessen the possibility of injury to a turtle, the raking process must be closely monitored so that it can be stopped immediately if a turtle is sighted.

b. Personnel should be instructed to look beneath surface debris before the rake is used to lessen the possibility of injury to a turtle.

c. Personnel cleaning the racks are to inspect all trash that is dumped, particularly at night. Many horseshoe crabs are caught on the racks; these might be confused with turtles or turtle parts.

5. Lighting must be maintained at the intake bays to enable inspection personnel to see the surface of each intake bay and to facilitate safe handling of turtles which are discovered at night. Portable spotlights should be available at both the CWS and the DWS for times when extra lighting is needed.

6. Live sea turtles are to be inspected for signs of illness or injury. Any ill or injured turtle is to be given appropriate medical attention, and must not be released until its condition has improved. Turtles are to be handled according to the attached procedures (Appendix I).

7. Live turtles that exhibit no signs of illness or injury are to be taken to an authorized agent of the Sea Turtle Stranding and Salvage Network to be evaluated, tagged, and released.

8. Dead sea turtles are to be necropsied by qualified personnel. Identification of sex should be determined and stomach contents should be identified to determine whether waste products from the trash racks or aggregations at the trash racks are attracting sea turtles. Necropsy reports should be submitted to NMFS with the annual review of incident reports or, if not yet available, when completed.

9. The monitoring and reporting system must follow the items outlined in Appendix II. Information in Appendix III will assist in identification of species impinged. These reports are to be sent to NMFS/Northeast Region within 30 days of any incidental take.

10. An annual report of incidental takes must be submitted to NMFS. This report will be used to identify trends and further conservation measures necessary to minimize incidental takes of sea turtles. The report should include, as detailed above, all necropsy reports, and a record of when inspections of the intake trash bars were conducted.

11. This Incidental Take Allowance extends for a period of five years from the date of the attached biological opinion. Reinitiation of consultation is required if, during any one year, twelve turtles are taken and/or there is a lethal take of one Kemp's ridley OR one green turtle.

TABLE 1

SEA TURTLE IMPINGEMENTS AT OYSTER CREEK NUCLEAR GENERATING STATION
1992 through 1994

ID #	DATE	TIME	CWS/DWS	SPECIES	CONDITION	SIZE	REMARKS
92-A	06/25/92	12:50 PM	DWS	Cc	Dead	35.5 cm 9.6 kg	Possible propeller wounds. MMSC necropsy.
92-B	09/09/92	6:00 PM	CWS	Cc	Live	46.7 cm 19.1 kg	Released into discharge canal; returned to CWS two days later.
92-B(2)	09/11/92	2:00 PM	CWS	Cc	Live	46.7 cm 19.1 kg	Same turtle as above. Taken to MMSC, tagged, and released.
92-1	10/26/92	3:00 AM	CWS	Lk	Live	32.0 cm 5.7 kg	Possible propeller wounds. Tagged, released by MMSC.
93-1	10/17/93	12:00 PM	DWS	Lk	Dead	26.0 cm 3.0 kg	Fresh dead. Empty stomach.
94-1	06/19/94	1:30 PM	CWS	Cc	Live	36.8 cm 9.8 kg	Swimming, eventually impinged. Tagged, released by MMSC.
94-2	07/01/94	10:00 AM	DWS	Lk	Dead.	27.7 cm 3.6 kg	Very decomposed. Sent to Cornell for necropsy.
94-3	07/06/94	6:40 AM	DWS	Cc	Dead	61.4 cm 40.4 kg	Healed propeller wounds. Full stomach.
94-4	07/12/94	10:40 PM	DWS	Lk	Dead	26.7 cm 3.3 kg	Sent to Cornell for necropsy.

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APPENDIX I (Handling and Resuscitation Procedures)

Handling:

Do not assume an inactive turtle is dead. Pressing the soft tissue around the nose of a sea turtle may result in an eye reflex in a comatose (unconscious) turtle. The onset of rigor mortis is often the only definite indication that a turtle is dead.

Keep clear of the head.

Adult male sea turtles of all species other than leatherbacks have claws on their foreflippers. Keep clear of slashing foreflippers.

Pick up sea turtles by the front and back of the top shell (carapace). Do not pick up sea turtles by flippers, the head or the tail.

Resuscitation Procedures:

If a turtle appears to be comatose, attempts should be made to revive it immediately.

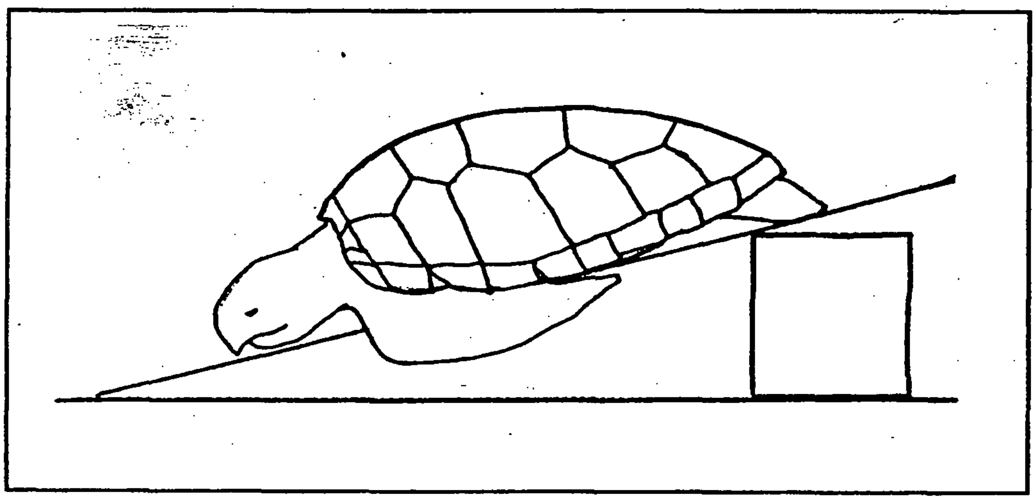
These procedures are designed to void the turtles' lungs of water by active pumping and passive drainage. Sea turtles have been known to revive up to 24 hours after these procedures have been followed:

1) Place the turtle on its back and gently pump the breastplate. This may stimulate the animal to breathe and allow water to drain.

2) Place the animal on its breastplate and raise the hindquarters. The degree of elevation depends on the size of the turtle; greater elevations are required for larger turtles.

4) Keep the turtle shaded and moist and observe for 24 hours.

5) When the turtle has revived, release in a manner that minimizes the chances of re-impingement.



Special Instructions for Cold-Stunned Turtles:

Comatose turtles found in water less than 10°C are probably "cold-stunned". This is most common in the fall and early winter. If a turtle appears to be cold-stunned, the following applies:

To increase blood flow, flap the flippers and rub the skin. Gradually, (over a period of six hours) move the turtle to a warmer area.

If possible, place the animal in a few inches of water that is warmer then the ocean. Do not cover the mouth or nostrils with water. It is not imperative that sea turtles be kept in water.

Dead sea turtles should be retained for necropsy.

APPENDIX II (Reporting Requirements)

Photographs should be taken and the information requested below should be collected in association with all protected species impingements. This documentation should be sent to the following address:

National Marine Fisheries Service
Habitat and Protected Resources Division
One Blackburn Drive
Gloucester, MA 01930-2298.

Protected Species Impingements at the Oyster Creek NGS

Observer's full name: ______________________________

Reporter's full name: ______________________________

Species Identification (Key attached): ______________________

Site of Impingement (CWS or DWS, Bay #, etc.): ______________

Date and time impingement observed: __________________

Date and time animal collected: ______________________

Tidal Stage at time of observation: __________________

Date and time of last inspection of screen: ______________

Water temperature at site and time of impingement: __________

Intake velocity at site and time of impingement (ft/sec): ______

Average percent of power generating capacity achieved per unit over the 48 hours previous to impingement: ______________

Condition of animal: ______________________________

Sea Turtle Measurements (indicate cm or in):

Carapace length - Curved: ____________ Straight: ____________

Carapace width - Curved: ____________ Straight: ____________

Tag number and location, if tagged: __________________

Remarks (include behavior of animal): __________________

____

____

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Results of necropsy (include sex and stomach contents): ______

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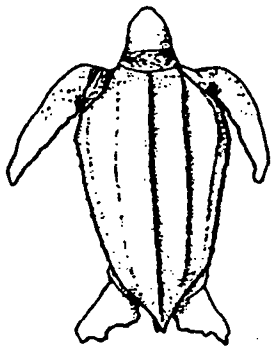
APPENDIX III (**Identification Materials**)

SEA TURTLES

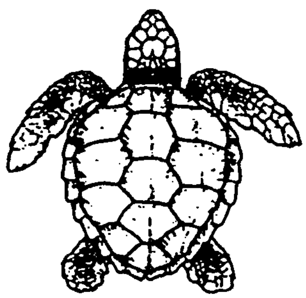
LBST



Leatherback -

Found in open water throughout the Northeast from spring through fall. Leathery shell with 5-7 ridges along the back. Largest sea turtle (4-6 feet). Dark green to black; may have white spots on flippers and underside.

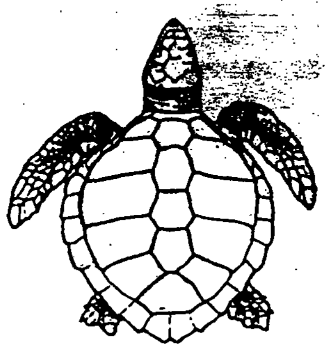
LGST



Loggerhead

Bony shell, reddish-brown in color. Mid-sized sea turtle (2-4 feet). Commonly seen from Cape Cod to Hatteras from spring through fall, especially in southern portion of range. Head large in relation to body.

RST

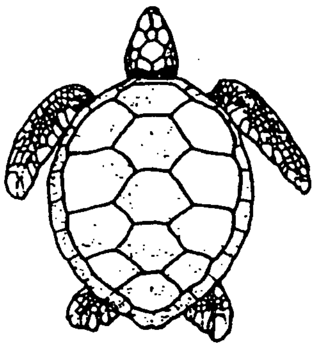


Kemp's ridley

Most often found in Bays and coastal waters from Cape Cod to Hatteras from summer through fall. Offshore occurrence undetermined. Bony shell, olive green to grey in color. Smallest sea turtle in Northeast (9-24 inches). Width equal to or greater than length.

SEA TURTLES (Cont'd.)

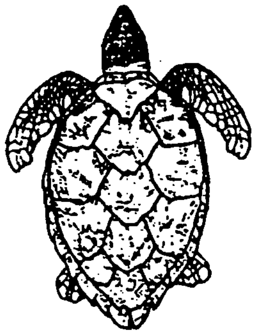
GST



Green turtle

Uncommon in the Northeast. Occur in Bays and coastal waters from Cape Cod to Hatteras in summer. Bony shell, variably colored; usually dark brown with lighter stripes and spots. Small to mid-sized sea turtle (1-3 feet). Head small in comparison to body size.

HST

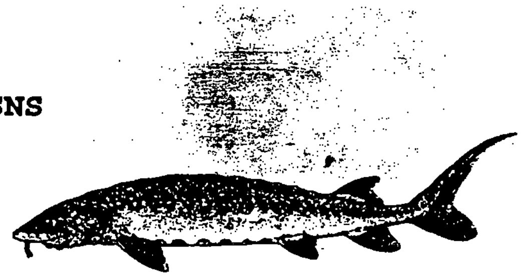


Hawksbill

Rarely seen in Northeast. Elongate bony shell with overlapping scales. Color variable, usually dark brown with yellow streaks and spots (tortoise-shell). Small to mid-sized sea turtle (1-3 feet). Head relatively small, neck long.

FISH

SNS



Shortnose sturgeon

Occur in the major river systems along the Atlantic seaboard. Found offshore only within a few miles of land. Shortnose have a wide mouth, short snout, and are brownish to black in color, with bony plates along the sides of the body. Rarely reach 4 feet.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
NORTHEAST REGION
One Blackburn Drive
Gloucester, MA 01930-2298

JUL 18 2001

Ms. Elinor G. Adensam, Director
Project Directorate I
Division of Licensing Project Management
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Dear Ms. Adensam:

Enclosed is the National Marine Fisheries Service's (NMFS) Biological Opinion on the impacts of the Oyster Creek Nuclear Generating Station (OCNGS), located near Forked River, New Jersey, on endangered and threatened species. This Biological Opinion was prepared pursuant to the inter-agency consultation requirements of Section 7 of the Endangered Species Act (ESA).

Based on our review of the OCNGS' Biological Assessment and supplementary information submitted by the Nuclear Regulatory Commission (NRC), and the available scientific information, NMFS concludes that the continued operation of the OCNGS may adversely affect but is not likely to jeopardize the continued existence of endangered Kemp's ridley, green, or threatened loggerhead sea turtles. NMFS has determined that the proposed action is likely to have no effect on endangered leatherback or hawksbill sea turtles.

The enclosed Biological Opinion provides an Incidental Take Statement (ITS) for threatened and endangered sea turtles, as well as reasonable and prudent measures and terms and conditions necessary for NRC to minimize impacts to these species. The ITS authorizes the annual take of five (5) loggerhead (no more than two (2) lethal), four (4) Kemp's ridley (no more than three (3) lethal), or two (2) green (no more than one (1) lethal) sea turtles for the continued operation of the OCNGS. The NMFS expects NRC to implement the reasonable and prudent measures and terms and conditions as outlined in the ITS. The measures of the ITS are non-discretionary and must be undertaken by NRC for the incidental take exemption to apply. For example, the OCNGS must establish an arrangement with a qualified facility or individual (with the appropriate ESA permit) to necropsy all dead sea turtles in suitable condition, prior to any incidental turtle take.

This Biological Opinion concludes formal consultation for the continued operation of the OCNGS. Reinitiation of this consultation is required if: (1) the amount or extent of taking specified in the ITS is exceeded; (2) new information reveals effects of these actions that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) project activities are subsequently modified in a manner that causes an effect to the listed species that was not considered in this Biological Opinion; or (4) a new species is listed or critical

habitat designated that may be affected by the identified actions. As identified in the Biological Opinion, NMFS Northeast Regional staff should be contacted immediately should an interaction with a sea turtle occur.

For further information regarding any consultation requirements, please contact Mary Colligan, Acting Assistant Regional Administrator for Protected Resources, NMFS Northeast Regional Office, at (978) 281-9116.

The NMFS appreciates your assistance with the protection of threatened and endangered sea turtles. I look forward to continued cooperation with NRC during future Section 7 consultations.

Sincerely,

Patricia A. Kurkul
Regional Administrator

cc: Brewer/Johnson, F/PR3
Malcolm Browne, AmerGen
Williams, GCNE
Riportella, F/NER-SH

File code: 1514-05(A) NRC – Oyster Creek

ENDANGERED SPECIES ACT SECTION 7 CONSULTATION

BIOLOGICAL OPINION

Agency: Nuclear Regulatory Commission

Activity: Continued operation of the Oyster Creek Nuclear Generating Station on the Forked River and Oyster Creek, Barnegat Bay, New Jersey (F/NER/2001/00658)

Conducted by: National Marine Fisheries Service, Northeast Regional Office

Date Issued: July 18, 2001

Approved by: [signature]

INTRODUCTION

This constitutes the National Marine Fisheries Service's (NMFS) biological opinion (Opinion) on the effects of the Nuclear Regulatory Commission's (NRC) continued operation of the Oyster Creek Nuclear Generating Station (OCNGS) on threatened and endangered species in accordance with section 7 of the Endangered Species Act of 1973, as amended (ESA; 16 USC 1531 et seq.).

This Opinion is based on information provided in the July 2000 Biological Assessment (BA), correspondence with Mr. Jim Wilson, NRC, and Mr. Malcolm Browne, AmerGen Energy Company, and other sources of information. A complete administrative record of this consultation is on file at the NMFS Northeast Regional Office, Gloucester, Massachusetts.

CONSULTATION HISTORY

The OCNGS began commercial operation in 1969. No observed takes of endangered species occurred at the OCNGS prior to 1992. However, between June 1992 and July 1994, 9 sea turtle impingements occurred at the OCNGS intake trash bars, including 5 loggerheads (4 individuals, 1 recapture), and 4 Kemp's ridleys. In a letter dated November 2, 1993, NMFS stated that formal consultation on the operation of the OCNGS was necessary due to takes of threatened and endangered sea turtles. In a letter dated November 19, 1993, the NRC requested formal consultation. A Biological Assessment was prepared by the OCNGS, reviewed and submitted by the NRC, and received by NMFS on January 25, 1995.

A Biological Opinion on the effects of the operation of OCNGS on loggerhead, green, and Kemp's ridley sea turtles was signed on September 21, 1995. This Opinion concluded that the continued operation of this station may adversely affect listed turtles, but is not likely to jeopardize their continued existence. The accompanying Incidental Take Statement permitted the annual take of 10 loggerhead (no more than 3 lethal), 3 Kemp's ridley (no more than 1 lethal), and 2 green (no more than 1 lethal) sea turtles. The Incidental Take Allowance extended for a period of 5 years from the date of the Opinion (i.e., to September 21, 2000).

After the 1995 Opinion was signed, there were nine takes of sea turtles associated with the OCNGS. The specifics of these takes are discussed in the following Effects of the Action section. The 1995 incidental take level was met during three of these years: in 1997 with the lethal take of a Kemp's ridley turtle, in 1999 with the lethal take of a green turtle, and again in 2000 with the lethal take of a Kemp's ridley turtle. However, these takes did not trigger reinitiation of formal consultation on OCNGS. Section 7 consultation must be reinitiated if the amount or extent of take as specified in the incidental take statement is exceeded (not met). In the cover letter accompanying the 1995 BO, NMFS stated that reinitiation would be required if, during any one year, twelve sea turtles are taken and/or there is a lethal take of one Kemp's ridley OR one green turtle. However, reinitiation is not actually required unless the Incidental Take Statement is exceeded. The Incidental Take Statement in the Opinion authorized the annual lethal take of one Kemp's ridley and one green turtle, and it is this take statement that sets the authorized take level.

On August 3, 2000, the NMFS was copied on a letter from the Acting Site Director of the OCNGS, Sander Levin, to the NRC, requesting the renewal of the Biological Opinion/Incidental Take Statement and submitting an updated BA. In a telephone conversation on August 24, 2000, NRC informed NMFS that shortly they would be sending a letter requesting reinitiation of formal consultation. On September 18, 2000, four days before the previous incidental take statement was to expire, NRC requested reinitiation of formal consultation on the effects of the OCNGS on sea turtles and submitted a revised BA. In a letter dated October 6, 2000, NMFS acknowledged the receipt of the formal consultation request and the BA. At that time, NMFS requested additional information, such as updated sea turtle take details, necropsy results, and updated New Jersey stranding records, before formal consultation could proceed.

During a telephone discussion in December 2000, NRC and AmerGen staff informed NMFS that information was not available for several items requested in NMFS' October 6 letter (e.g., updated necropsy information). On January 23, 2001, the NRC submitted supplemental information and clarification on the BA as requested by NMFS. NRC also identified areas where data were lacking or unavailable.

On February 2, 2001, NMFS informed NRC that all of the information necessary for a formal section 7 consultation and the preparation of a Biological Opinion had been received and reminded NRC not to make any irreversible or irretrievable commitment of resources that would prevent the NMFS from proposing or the NRC from implementing any reasonable and prudent alternatives to avoid jeopardizing sea turtles. Until consultation is concluded, NMFS recommended that the NRC continue to implement the requirements identified in the September 21, 1995, Opinion.

DESCRIPTION OF THE PROPOSED ACTION

The proposed activity is the continued operation of the Oyster Creek Nuclear Generating Station. OCNGS is located near the town of Forked River, midway between the south branch of the Forked River and Oyster Creek, New Jersey (Figure 1). The Forked River and Oyster Creek empty into Barnegat Bay. When the plant is operational, the flow direction in the south fork of the Forked River is reversed, and all of the flow goes into the OCNGS. The resultant warmed water is discharged via Oyster Creek into Barnegat Bay.

OCNGS consists of a boiling water nuclear reactor with an electrical capability of approximately 650 megawatts. Two separate intake structures withdraw water from the intake canal, the circulating water system intake (CWS) and the dilution water system (DWS).

The CWS provides cooling water for the main condensers and for safety-related heat exchangers and other equipment within the station. Water is drawn into the CWS from the intake canal (south fork of the Forked River) through six intake bays and is subsequently discharged into the discharge canal as heated effluent. During normal plant operation, four circulating water pumps withdraw a total of 1740 m^3/min of water, and the maximum permissible average intake velocity for water approaching the CWS intake ports is 30 cm/sec. The maximum effluent temperature is 41.1 C.

The DWS minimizes the thermal effects on the discharge canal and Barnegat Bay by thermally diluting the circulating water from the condenser with colder ambient temperature water. Water is pumped from the intake canal through the six intake bays and discharged directly into the discharge canal, where it mixes with and reduces the temperature of the heated effluent from the CWS. A maximum of two dilution pumps are operated at one time, but when water temperature exceeds 30.5 C, usually only one dilution pump is put into operation. The average intake velocity for water in front of the DWS intake (with two pumps in operation) is approximately 73 cm/sec. As expected, the average intake velocity with one DWS pump in operation is notably less than 73 cm/sec.

The dimensions and structures at the CWS are nearly identical to those of the DWS. Several differences are that the intake velocity at the DWS is much higher than at the CWS, and the CWS has a vertical traveling screen to filter small organisms. The intakes at both the CWS and DWS are screened by six sets of trash bars, which extend from the bottom of each intake bay to several feet above the water (7.3 m high and 3.3 m wide). The depth at the intake bays are approximately 4 to 6 meters deep. The trash bars are 0.95 cm wide steel bars set on 7.5 cm centers, and the openings between the trash bars are 6.6 cm wide. A trash rake assembly traverses the entire width of the intake on rails; it contains a trash hopper which transports the material removed from the bars to a debris container. Personnel cleaning the CWS and DWS intake trash racks from June to October observe the trash rake during the cleaning operation so that the rake may be stopped if a sea turtle is sighted. The trash bars are inspected at least twice during each 8-hour work shift from June to October to remove debris and to monitor potential sea turtle takes.

A floating debris/ice barrier has been designed and installed upstream of the CWS and DWS intake structures to divert floating debris (e.g., wood, eelgrass, ice) away from the CWS intake and towards the DWS intake. The barrier is intended to prevent excessive amounts of debris or ice from accumulating on the CWS traveling screen or trash bars. The wood floating barrier extends 60 cm below the surface, so that if a turtle is near the surface when approaching the floating barrier, it may be diverted towards the DWS unless it dives deeper and turns towards the CWS.

Both intakes have sea turtle retrieval/rescue equipment on site in the event of a sea turtle impingement. At the CWS intake structure, a rescue sling suitable for lifting large sea turtles (in excess of 20 kg) is present. Long-handled dipnets are present at the CWS and DWS intake structures during June through October, and are suitable for retrieving the smaller turtles which are more likely to be found at the OCNGS. Both the rescue sling and the long-handled dipnets

are only adequate for retrieving turtles from the water surface or within about 1 meter of the surface, as the use of either device requires that the sea turtle be visible from the surface.

Action Area
The project area includes the area immediately surrounding the OCNGS, including the Forked River and Oyster Creek. For the purpose of this analysis, the action area also encompasses the entire Barnegat Bay.

STATUS OF SPECIES OR CRITICAL HABITAT

NMFS has determined that the action being considered in this Opinion is not expected to affect leatherback (*Dermochelys coriacea*) or hawksbill (*Eretmochelys imbricata*) sea turtles, which are listed as endangered under the ESA.

Leatherback sea turtle
Leatherbacks are widely distributed throughout the oceans of the world, and are found in waters of the Atlantic, Pacific, Caribbean, and the Gulf of Mexico (Ernst and Barbour 1972). In the U.S. Atlantic Ocean, leatherback turtles are found in northeastern waters during the warmer months. This species is found in coastal waters of the continental shelf and near the Gulf Stream edge, but rarely in the inshore areas (Lutcavage 1996). Leatherbacks are predominantly a pelagic species and feed on jellyfish, cnidarians and tunicates.

Estimated to number approximately 115,000 adult females globally in 1980 (Pritchard 1982) and only 34,500 by 1995 (Spotila *et al.* 1996), leatherback populations have been decimated worldwide, not only by fishery related mortality but, at least historically, primarily due to intense exploitation of the eggs (Ross 1979). The status of the leatherback population in the Atlantic is difficult to assess since major nesting beaches occur over broad areas within tropical waters outside the United States. Recent information suggests that Western Atlantic populations declined from 18,800 nesting females in 1996 (Spotila et al., 1996) to 15,000 nesting females by 2000 (Spotila, pers. comm).

Leatherbacks have been documented in waters off New Jersey and have also been found stranded on New Jersey coastal and estuarine beaches. Shoop and Kenney (1992) observed concentrations of leatherbacks during the summer off the south shore of Long Island and off New Jersey. Leatherbacks in these waters are thought to be following their preferred jellyfish prey. This aerial survey estimated the leatherback population for the northeastern U.S. at approximately 300-600 animals (from near Nova Scotia, Canada to Cape Hatteras, North Carolina).

The only direct access to Barnegat Bay, the action area, from the Atlantic Ocean is through a single, narrow inlet, approximately 300 m wide. While leatherbacks could enter Barnegat Bay, it is improbable given that this species is rarely found in inshore waters. Furthermore, given this species' distribution and migratory and foraging patterns, it is also unlikely that this species will travel through the navigation channels to reach the OCNGS. As a result, it is highly unlikely that the action being considered in this Opinion will affect leatherback sea turtles.

Hawksbill sea turtle
The hawksbill turtle is relatively uncommon in the waters of the continental United States. Hawksbills prefer coral reefs, such as those found in the Caribbean and Central America.

Hawksbills feed primarily on a wide variety of sponges but also consume bryozoans, coelenterates, and mollusks. The Culebra Archipelago of Puerto Rico contains especially important foraging habitat for hawksbills. Nesting areas in the western North Atlantic include Puerto Rico and the Virgin Islands.

There are accounts of hawksbills in south Florida and a number are encountered in Texas. Most of the Texas records report small turtles, probably in the 1-2 year class range. Many captures or strandings are of individuals in an unhealthy or injured condition. The lack of sponge-covered reefs and the cold winters in the northern Gulf of Mexico probably prevent hawksbills from establishing a viable population in this area. In the north Atlantic, small hawksbills have stranded as far north as Cape Cod, Massachusetts. However, many of these strandings were observed after hurricanes or offshore storms. No takes of hawksbill sea turtles have been recorded in Northeast or mid-Atlantic fisheries covered by the Northeast Fisheries Science Center (NEFSC) observer program, but it should be noted that coverage has been limited in the past.

While hawksbills have occasionally been found in northern mid-Atlantic waters, it is improbable that this species will be present in the action area given its distribution, and migratory and foraging patterns. Thus, it is highly unlikely that the action being considered in this Opinion will affect hawksbill sea turtles.

The following endangered or threatened species under NMFS' jurisdiction are likely to occur in the action area.

Threatened:
Loggerhead sea turtle (*Caretta caretta*)

Endangered:
Green sea turtle[1] (*Chelonia mydas*)
Kemp's ridley sea turtle (*Lepidochelys kempi*)

No critical habitat has been designated for species under NMFS' jurisdiction in the action area, so no critical habitat will be affected by the proposed project.

Loggerhead sea turtle

Loggerhead sea turtles occur throughout the temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans in a wide range of habitats. These include open ocean, continental shelves, bays, lagoons, and estuaries (NMFS and USFWS, 1995). It is the most abundant species of sea turtle in U.S. waters, commonly occurring throughout the inner continental shelf from Florida through Cape Cod, Massachusetts. NMFS Northeast Fisheries Science Center survey data (1999) has found that loggerheads may occur as far north as Nova Scotia when oceanographic and prey conditions are favorable. The loggerhead sea turtle was listed as threatened under the ESA on July 28, 1978, but is considered endangered by the World Conservation Union (IUCN).

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[1]Green turtles in U.S. waters are listed as threatened except for the Florida breeding population which is listed as endangered. Due to the inability to distinguish between these populations away from the nesting beach, green turtles are considered endangered wherever they occur in U.S. waters.

Loggerhead sea turtles are generally grouped by their nesting locations. Nesting is concentrated in the north and south temperate zones and subtropics. Loggerheads generally avoid nesting in tropical areas of Central America, northern South America, and the Old World (National Research Council 1990). The largest known nesting aggregations of loggerhead sea turtles occurs on Masirah and Kuria Muria Islands in Oman (Ross and Barwani 1982). However, the status of the Oman nesting beaches has not been evaluated recently, and their location in a part of the world that is vulnerable to extremely disruptive events (e.g. political upheavals, wars, and catastrophic oil spills) is cause for considerable concern (Meylan et al. 1995). The southeastern U.S. nesting aggregation is the second largest and represents about 35 percent of the nests of this species. From a global perspective, this U.S. nesting aggregations is, therefore, critical to the survival of this species.

In the western Atlantic, most loggerhead sea turtles nest from North Carolina to Florida and along the gulf coast of Florida. In 1996, the Turtle Expert Working Group (TEWG) met on several occasions and produced a report assessing the status of the loggerhead sea turtle population in the western North Atlantic. Based on analysis of mitochondrial DNA, which the turtle inherits from its mother, the TEWG theorized that nesting assemblages represent distinct genetic entities, and that there are at least four loggerhead subpopulations in the western North Atlantic separated at the nesting beach (TEWG 1998, 2000). A fifth subpopulation was identified in NMFS SEFSC 2001. The subpopulations are divided geographically as follows: (1) a northern nesting subpopulation, occurring from North Carolina to northeast Florida, about 29° N (approximately 7,500 nests in 1998); (2) a south Florida nesting subpopulation, occurring from 29° N on the east coast to Sarasota on the west coast (approximately 83,400 nests in 1998); (3) a Florida panhandle nesting subpopulation, occurring at Eglin Air Force Base and the beaches near Panama City, Florida (approximately 1,200 nests in 1998); (4) a Yucatán nesting subpopulation, occurring on the eastern Yucatán Peninsula, Mexico (Márquez 1990; approximately 1,000 nests in 1998); and (5) a Dry Tortugas nesting subpopulation, occurring in the islands of the Dry Tortugas, near Key West, Florida (approximately 200 nests per year). Natal homing to the nesting beach is believed to provide the genetic barrier between these nesting aggregations, preventing recolonization from turtles from other nesting beaches. In addition, recent fine-scale analysis of mtDNA work from Florida rookeries indicate that population separations begin to appear between nesting beaches separated by more than 50-100 km of coastline that does not host nesting (Francisco et al. 1999) and tagging studies are consistent with this result (Richardson 1982, Ehrhart 1979, LeBuff 1990, CMTTP: in NMFS SEFSC 2001). Nest site relocations greater than 100 km occur, but are rare (Ehrhart 1979; LeBuff 1974, 1990; CMTTP; Bjorndal et at. 1983: in NMFS SEFSC 2001).

Although NMFS has not formally recognized subpopulations of loggerhead sea turtles under the ESA, based on the most recent reviews of the best scientific and commercial data on the population genetics of loggerhead sea turtles and analyses of their population trends (TEWG, 1998; TEWG 2000), NMFS treats the loggerhead turtle nesting aggregations as nesting subpopulations whose survival and recovery is critical to the survival and recovery of the species. Any action that appreciably reduced the likelihood that one or more of these nesting aggregations would survive and recover would appreciably reduce the species' likelihood of survival and recovery in the wild. Consequently, this biological opinion will treat the five nesting aggregations of loggerhead sea turtles as subpopulations (which occur in the action area) for the purposes of this analysis.

The loggerhead sea turtles in the action area of this consultation likely represent turtles that have hatched from any of the five western Atlantic nesting sites, but are probably composed primarily of turtles that hatched from the northern nesting group and the south Florida nesting group. Although genetic studies of benthic immature loggerheads on the foraging grounds have shown the foraging areas to be comprised of a mix of individuals from different nesting areas, there appears to be a preponderance of individuals from a particular nesting area in some foraging locations. For example, although the northern nesting group (North Carolina to northeast Florida) produces only about 9 percent of the loggerhead nests, loggerheads from this nesting area comprise between 25 and 59 percent of the loggerhead sea turtles found in foraging areas from the northeastern U.S. to Georgia (NMFS SEFSC 2001; Bass et al., 1998; Norrgard, 1995; Rankin-Baransky, 1997; Sears 1994, Sears et al., 1995). Loggerheads that forage from Chesapeake Bay southward to Georgia are nearly equally divided in origin between south Florida and the northern nesting group (TEWG, 1998). In the Carolinas, the northern subpopulation is estimated to make up from 25 to 28 percent of the loggerheads (NMFS SEFSC 2001; Bass *et al.* 1998). About 10 percent of the loggerhead sea turtles in foraging areas off the Atlantic coast of central Florida are from the northern subpopulation (Witzell, in prep). In the Gulf of Mexico, most of the loggerhead sea turtles in foraging areas will be from the South Florida subpopulation, although the northern subpopulation may represent about 10 percent of the loggerhead sea turtles in the Gulf (Bass, pers. comm.).

Similar mixing trends have been found for loggerheads in pelagic waters. In the Mediterranean Sea, about 45 - 47 percent of the pelagic loggerheads can be traced to the South Florida subpopulation and about 2 percent are from the northern subpopulation, while only about 51 percent originated from Mediterranean nesting beaches (Laurent et al., 1998). In the vicinity of the Azores and Madiera Archipelagoes, about 19 percent of the pelagic loggerheads are from the northern subpopulation, about 71 percent are from the South Florida subpopulation, and about 11 percent are from the Yucatán subpopulation (Bolten et al., 1998).

Loggerhead sea turtles originating from the western Atlantic nesting aggregations are believed to lead a pelagic existence in the North Atlantic Gyre for as long as 7-12 years before settling into benthic environments. Turtles in this life history stage are called "pelagic immatures" and are best known from the eastern Atlantic near the Azores and Madeira and have been reported from the Mediterranean as well as the eastern Caribbean (Bjorndal et al., in press). Stranding records indicate that when pelagic immature loggerheads reach 40-60 cm straight-line carapace length (SCL) they move to coastal inshore and nearshore waters of the continental shelf throughout the U.S. Atlantic and Gulf of Mexico. However, recent studies have suggested that not all loggerhead sea turtles follow the model of circumnavigating the North Atlantic Gyre as pelagic immatures, followed by permanent settlement into benthic environments. Some may not totally circumnavigate the north Atlantic before moving to benthic habitats, while others may either remain in the pelagic habitat longer than hypothesized or move back and forth between pelagic and coastal habitats (Witzell in prep.).

Benthic immatures have been found from Cape Cod, Massachusetts, to southern Texas, and occasionally strand on beaches in northeastern Mexico (R. Márquez-M., pers. comm.). Large benthic immature loggerheads (70-91 cm) represent a larger proportion of the strandings and in-water captures (Schroeder et al., 1998) along the south and western coasts of Florida as compared with the rest of the coast, but it is not known whether the larger animals are actually more abundant in these areas or just more abundant within the area relative to the smaller turtles. Given an estimated age at maturity of 17-35 years (Frazer and Ehrhart 1985; B. Schroeder, pers.

comm.), the benthic immature stage must be at least 10-25 years long. As discussed in the beginning of this section, adult loggerheads nest primarily from North Carolina southward to Florida with additional nesting assemblages in the Florida Panhandle and on the Yucatán Peninsula. Non-nesting, adult female loggerheads are reported throughout the U.S. and Caribbean Sea; however, little is known about the distribution of adult males who are seasonally abundant near nesting beaches during the nesting season. NMFS SEFSC (2001) analyses conclude that juvenile stages have the highest elasticity and maintaining or decreasing current sources of mortality in those stages will have the greatest impact on maintaining or increasing population growth rates.

Aerial surveys suggest that loggerheads (benthic immatures and adults) in U.S. waters are distributed in the following proportions: 54% in the southeast U.S. Atlantic, 29% in the northeast U.S. Atlantic, 12% in the eastern Gulf of Mexico, and 5% in the western Gulf of Mexico (TEWG 1998). Like other sea turtles, the movements of loggerheads are influenced by water temperature. Since they are limited by water temperatures, loggerhead sea turtles do not usually appear on the northern summer foraging grounds (e.g., in the action area) until June, but can be found in Virginia as early as April. The large majority leave the Gulf of Maine by mid-September but may remain in the Northeast and mid-Atlantic waters until as late as November or December (Epperly et al., 1995; Keinath 1993; Morreale 1999; Shoop and Kenney 1992). Loggerhead sea turtles are primarily benthic feeders, opportunistically foraging on crustaceans and mollusks (Wynne and Schwartz, 1999). Under certain conditions they may also scavenge fish, particularly if they are easy to catch (e.g., caught in nets; NMFS and USFWS, 1991).

Threats to loggerheads' recovery

The five major subpopulations of loggerhead sea turtles in the northwest Atlantic — northern, south Florida, Florida panhandle, Yucatán, and Dry Tortugas — are all subject to fluctuations in the number of young produced annually because of human-related activities as well as natural phenomena. Loggerhead sea turtles face numerous threats from natural causes. For example, there is a significant overlap between hurricane seasons in the Caribbean Sea and northwest Atlantic Ocean (June to November), and the loggerhead sea turtle nesting season (March to November). Sand accretion and rainfall that result from these storms as well as wave action can appreciably reduce hatchling success. In 1992, Hurricane Andrew affected turtle nests over a 90-mile length of coastal Florida; all of the eggs were destroyed by storm surges on beaches that were closest to the eye of this hurricane (Milton et al., 1992). On Fisher Island near Miami, Florida, 69 percent of the eggs did not hatch after Hurricane Andrew, probably because they were drowned by the storm surge. Nests from the northern nesting group were destroyed by hurricanes which made landfall in North Carolina in the mid to late 1990's. Other sources of natural mortality include cold stunning and biotoxin exposure.

The diversity of the sea turtle's life history leaves them susceptible to many human impacts, including impacts while they are on land, in the benthic environment, and in the pelagic environment. On their nesting beaches in the U.S., adult female loggerheads as well as hatchlings are threatened with beach erosion, armoring, and nourishment; artificial lighting; beach cleaning; increased human presence; recreational beach equipment; beach driving; coastal construction and fishing piers; exotic dune and beach vegetation; predation by species such as exotic fire ants, raccoons (*Procyon lotor*), armadillos (*Dasypus novemcinctus*), opossums (*Didelphus virginiana*); and poaching. Although sea turtle nesting beaches are protected along large expanses of the northwest Atlantic coast (in areas like Merrit Island, Archie Carr, and Hobe Sound National Wildlife Refuges), other areas along these coasts have limited or no protection

and probably cause fluctuations in sea turtle nesting success. For example, Volusia County, Florida, allows motor vehicles to drive on sea turtle nesting beaches (the County has filed suit against the U.S. Fish and Wildlife Service to retain this right). Sea turtle nesting and hatching success on unprotected high density east Florida nesting beaches from Indian River to Broward County are affected by all of the above threats.

Loggerhead sea turtles are impacted by a completely different set of threats from human activities once they migrate to the ocean. Pelagic immature loggerhead sea turtles from these four subpopulations circumnavigate the North Atlantic over several years (Carr 1987, Bjorndal et al. 1994). During that period, they are exposed to a series of long-line fisheries that include the U.S. Atlantic tuna and swordfish longline fisheries, an Azorean long-line fleet, a Spanish long-line fleet, and various fleets in the Mediterranean Sea (Aguilar et al., 1995, Bolten et al., 1994, Crouse 1999). Observer records indicate that an estimated 6,544 loggerheads were captured by the U.S. Atlantic tuna and swordfish longline fleet between 1992-1998, of which an estimated 43 were dead (Yeung et al. in prep.). Logbooks and observer records indicated that loggerheads readily ingest hooks (Witzell 1999).

In waters off the coastal U.S., loggerhead sea turtles are exposed to a suite of fisheries in Federal and State waters including trawl, purse seine, hook and line, gillnet, pound net, longline, and trap fisheries. For example, loggerhead sea turtles have been captured in fixed pound net gear in the Long Island Sound, in pound net gear and trawls in summer flounder and other finfish fisheries in the mid-Atlantic and Chesapeake Bay, and in gillnet fisheries (e.g., monkfish, spiny dogfish) in the mid-Atlantic and elsewhere. The take of sea turtles, including loggerheads, in shrimp fisheries off the Atlantic coast have been well documented. It has previously been observed that loggerhead turtle populations along the southeastern Atlantic coast declined where shrimp fishing was intense off the nesting beaches but, conversely, did not appear to be declining where nearshore shrimping effort was low or absent (National Research Council 1990).

In addition to fishery interactions, loggerhead sea turtles also face other threats in the marine environment, including the following: oil and gas exploration, development, and transportation; marine pollution; underwater explosions; hopper dredging, offshore artificial lighting; power plant entrainment and/or impingement; entanglement in debris; ingestion of marine debris; marina and dock construction and operation; boat collisions; and poaching.

Status and trend of loggerhead sea turtles

Based on the data available, it is difficult to estimate the size of the loggerhead sea turtle population in the U.S. or its territorial waters. There is, however, general agreement that the number of nesting females provides a useful index of the species' population size and stability at this life stage. Nesting data collected on index nesting beaches in the U.S. from 1989-1998 represent the best dataset available to index the population size of loggerhead sea turtles. However, an important caveat for population trends analysis based on nesting beach data is that this may reflect trends in adult nesting females, but it may not reflect overall population growth rates. Given this, between 1989 and 1998, the total number of nests laid along the U.S. Atlantic and Gulf coasts ranged from 53,014 to 92,182 annually, with a mean of 73,751. Since a female often lays multiple nests in any one season, the average adult female population of 44,780 was calculated using the equation [(nests/4.1) * 2.5]. These data provide an annual estimate of the number of nests laid per year while indirectly estimating both the number of females nesting in a particular year (based on an average of 4.1 nests per nesting female, Murphy and Hopkins (1984)) and of the number of adult females in the entire population (based on an average

remigration interval of 2.5 years; Richardson et al., 1978)). On average, 90.7% of these nests were of the south Florida subpopulation, 8.5% were from the northern subpopulation, and 0.8% were from the Florida Panhandle nest sites. There is limited nesting throughout the Gulf of Mexico west of Florida, but it is not known to what subpopulation the turtles making these nests belong. Based on the above, there are only an estimated approximately 3,800 nesting females in the northern loggerhead subpopulation. The status of this northern population based on number of loggerhead nests, has been classified as stable or declining (TEWG 2000). Another consideration adding to the vulnerability of the northern subpopulation is that NMFS scientists estimate, using genetics data from Texas, South Carolina, and North Carolina in combination with juvenile sex ratios from those states, that the northern subpopulation produces 65% males, while the south Florida subpopulation is estimated to produce 80% females (NMFS SEFSC 2001, Part I).

Several published reports have presented the problems facing long-lived species that delay sexual maturity (Crouse et al., 1987, Crowder et al., 1994, Crouse 1999). In general, these reports concluded that animals that delay sexual maturity and reproduction must have high annual survival as juveniles through adults to ensure that enough juveniles survive to reproductive maturity and then reproduce enough times to maintain stable population sizes. This general rule applies to sea turtles, particularly loggerhead sea turtles, as the rule originated in studies of sea turtles (Crouse et al., 1987, Crowder et al., 1994, Crouse 1999). Crouse (1999) concluded that relatively small decreases in annual survival rates of both juvenile and adult loggerhead sea turtles will adversely affect large segments of the total loggerhead sea turtle population. The survival of hatchlings seems to have the least amount of influence on the survivorship of the species, but historically, the focus of sea turtle conservation has been involved with protecting the nesting beaches. While nesting beach protection and hatchling survival are important, recovery efforts and limited resources might be more effective by focusing on the protection of juvenile and adult sea turtles.

<u>Green sea turtle</u>

Green turtles are the largest chelonid (hard-shelled) sea turtle, with an average adult carapace of 91 cm SCL and weight of 150 kg. Ninety percent of green turtles found in Long Island Sound are between 25 and 40 cm SCL, with the largest reported being 68 cm (Burke et al. 1991). Based on growth rate studies of wild green turtles, greens have been found to grow slowly with an estimated age of sexual maturity ranging from 18 to 40 years (Balazs 1982, Frazer and Ehrhard 1985 in NMFS and USFWS 1991a, B. Schroeder pers. comm.).

Green turtles are distributed circumglobally. In the western Atlantic they range from Massachusetts to Argentina, including the Gulf of Mexico and Caribbean (Wynne and Schwartz, 1999). As is the case for loggerhead and Kemp's ridley sea turtles, green sea turtles use mid-Atlantic and northern areas of the western Atlantic Ocean as important summer developmental habitat. Green turtles are found in estuarine and coastal waters as far north as Long Island Sound, Chesapeake Bay, and North Carolina sounds (Musick and Limpus 1997). Like loggerheads and Kemp's ridleys, green sea turtles that use northern waters during the summer must return to warmer waters when water temperatures drop, or face the risk of cold stunning. Cold stunning of green turtles may occur in southern areas as well (i.e., Indian River, Florida), as these natural mortality events are dependent on water temperatures and not solely geographical location.

In the continental United States, green turtle nesting occurs on the Atlantic coast of Florida (Ehrhart 1979). Occasional nesting has been documented along the Gulf coast of Florida, at southwest Florida beaches, as well as the beaches on the Florida Panhandle (Meylan et al., 1995). Certain Florida nesting beaches where most green turtle nesting activity occurs have been designated index beaches. Index beaches were established to standardize data collection methods and effort on key nesting beaches. The pattern of green turtle nesting shows biennial peaks in abundance, with a generally positive trend during the ten years of regular monitoring since establishment of the index beaches in 1989, perhaps due to increased protective legislation throughout the Caribbean (Meylan et al., 1995). Recently, green turtle nesting occurred on Bald Head Island, North Carolina just east of the mouth of the Cape Fear River, on Onslow Island, and on Cape Hatteras National Seashore. Increased nesting has also been observed along the Atlantic Coast of Florida, on beaches where only loggerhead nesting was observed in the past (Pritchard 1997). Recent population estimates for green turtles in the western Atlantic area are not available.

While nesting activity is obviously important in assessing population trends, the remaining portion of the green turtle's life is spent on the foraging and breeding grounds. Juvenile green sea turtles occupy pelagic habitats after leaving the nesting beach. Pelagic juveniles are assumed to be omnivorous, but with a strong tendency toward carnivory during early life stages. At approximately 20 to 25 cm carapace length, juveniles leave pelagic habitats and enter benthic foraging areas, shifting to a chiefly herbivorous diet (Bjorndal 1997). Green turtles appear to prefer marine grasses and algae in shallow bays, lagoons and reefs (Rebel 1974), but also consume jellyfish, salps, and sponges. Some of the principal feeding pastures in the western Atlantic Ocean include the upper west coast of Florida and the northwestern coast of the Yucatan Peninsula. Additional important foraging areas in the western Atlantic include the Mosquito and Indian River Lagoon systems and nearshore wormrock reefs between Sebastian and Ft. Pierce Inlets in Florida, Florida Bay, the Culebra archipelago and other Puerto Rico coastal waters, the south coast of Cuba, the Mosquito Coast of Nicaragua, the Caribbean Coast of Panama, and scattered areas along Colombia and Brazil (Hirth 1971).

Threats to green turtles' recovery

Green turtles were traditionally highly prized for their flesh, fat, eggs, and shell, and directed fisheries in the United States and throughout the Caribbean are largely to blame for the decline of the species. In the Gulf of Mexico, green turtles were once abundant enough in the shallow bays and lagoons to support a commercial fishery. In 1890, over one million pounds of green turtles were taken in the Gulf of Mexico green sea turtle fishery (Doughty 1984). However, declines in the turtle fishery throughout the Gulf of Mexico were evident by 1902 (Doughty 1984).

Fibropapillomatosis, an epizootic disease producing lobe-shaped tumors on the soft portion of a turtle's body, has been found to infect green turtles, most commonly juveniles. The occurrence of fibropapilloma tumors, most frequently documented in Hawaiian green turtles, may result in impaired foraging, breathing, or swimming ability, leading potentially to death.

Green turtles continue to be heavily exploited by man, with the degradation of nesting and foraging habitats, incidental capture in fisheries, and marine pollution acknowledged as serious hindrances to species recovery. As with the other sea turtle species, fishery mortality accounts for a large proportion of annual anthropogenic mortality outside the nesting beaches, while other activities like dredging, pollution, and habitat destruction account for an unknown level of mortality. Sea sampling coverage in the pelagic driftnet, pelagic longline, scallop dredge,

southeast shrimp trawl, and summer flounder bottom trawl fisheries has recorded takes of green turtles. Stranding reports indicate that between 200-400 green turtles strand annually along the Eastern U.S. coast from a variety of causes, most of which are unknown (Sea Turtle Stranding and Salvage Network, unpublished data).

Kemp's ridley sea turtle

The Kemp's ridley is the most endangered of the world's sea turtle species. Of the world's seven extant species of sea turtles, the Kemp's ridley has declined to the lowest population level. Kemp's ridleys nest primarily on Rancho Nuevo in Tamaulipas, Mexico, where nesting females emerge synchronously during the day to nest in aggregations known as arribadas. Most of the population of adult females nest in this single locality (Pritchard 1969).

Kemp's ridley nesting occurs from April through July each year. Little is known about mating but it is believed to occur at or before the nesting season in the vicinity of the nesting beach. Hatchlings emerge after 45-58 days. Once they leave the beach, neonates presumably enter the Gulf of Mexico where they feed on available sargassum and associated infauna or other epipelagic species (USFWS and NMFS, 1992). Research conducted by Texas A&M University has resulted in the intentional live-capture of hundreds of Kemp's ridleys at Sabine Pass and the entrance to Galveston Bay. Between 1989 and 1993, 50 of the Kemp's ridleys captured were tracked (using satellite and radio telemetry) by biologists with the NMFS Galveston Laboratory. The tracking study was designed to characterize sea turtle habitat and to identify small and large scale migration patterns. Preliminary analysis of the data collected during these studies suggests that subadult Kemp's ridleys stay in shallow, warm, nearshore waters in the northern Gulf of Mexico until cooling waters force them offshore or south along the Florida coast (Renaud, NMFS Galveston Laboratory, pers. comm.). Ogren (1988) suggests that the Gulf coast, from Port Aransas, Texas, through Cedar Key, Florida, represents the primary habitat for subadult ridleys in the northern Gulf of Mexico. However, at least some juveniles will travel northward as water temperatures warm to feed in productive coastal waters of Georgia through New England (USFWS and NMFS, 1992).

Juvenile Kemp's ridleys use northeastern and mid-Atlantic coastal waters of the U.S. Atlantic coastline as primary developmental habitat during summer months, with shallow coastal embayments serving as important foraging grounds. Ridleys found in mid-Atlantic waters are primarily post-pelagic juveniles averaging 40 cm in carapace length, and weighing less than 20 kg (Terwilliger and Musick 1995). Next to loggerheads, they are the second most abundant sea turtle in mid-Atlantic waters, arriving in these areas during late May and June (Keinath et al., 1987; Musick and Limpus, 1997). In the Chesapeake Bay, where the juvenile population of Kemp's ridley sea turtles is estimated to be 211 to 1,083 turtles (Musick and Limpus 1997), ridleys frequently forage in shallow embayments, particularly in areas supporting submerged aquatic vegetation (Lutcavage and Musick 1985; Bellmund et al., 1987; Keinath et al., 1987; Musick and Limpus 1997). Other studies have found that post-pelagic ridleys feed primarily on crabs, consuming a variety of species. Mollusks, shrimp, and fish are consumed less frequently (Bjorndal 1997).

With the onset of winter and the decline of water temperatures, Kemp's ridleys migrate to more southerly waters from September to November (Keinath et al. 1987; Musick and Limpus 1997). Turtles that do not head south before water temperatures drop rapidly face the risk of cold-stunning. Cold stunning can be a significant natural cause of mortality for sea turtles in Cape Cod Bay and Long Island Sound. For example, in the winter of 1999/2000, there was a major

cold-stunning event where 218 Kemp's ridleys, 54 loggerheads, and 5 green turtles were found on Cape Cod beaches (R. Prescott, pers. comm.). Annual cold stun events only occasionally occur at this magnitude; the extent of episodic major cold stun events may be associated with numbers of turtles utilizing Northeast waters in a given year, oceanographic conditions and the occurrence of storm events in the late fall. Cold stunned turtles have also been reported on beaches in New York and New Jersey (Morreale et al., 1992). Although cold stun turtles can survive if found early enough, cold stunning events can represent a significant cause of natural mortality.

From telemetry studies, Morreale and Standora (1994) determined that Kemp's ridleys are sub-surface animals that frequently swim to the bottom while diving. The generalized dive profile showed that the turtles spend 56% of their time in the upper third of the water column, 12% in mid-water, and 32% on the bottom. In water shallower than 15 m (50 ft), the turtles dive to depth, but spend a considerable portion of their time in the upper portion of the water column. In contrast, turtles in deeper water dive to depth, spending as much as 50% of the dive on the bottom.

Threats to Kemp's ridleys' recovery
Like other turtle species, the severe decline in the Kemp's ridley population appears to have been heavily influenced by a combination of exploitation of eggs and impacts from fishery interactions. From the 1940's through the early 1960's, nests from Ranch Nuevo were heavily exploited (USFWS and NMFS, 1992), but beach protection in 1966 helped to curtail this activity (USFWS and NMFS, 1992). Currently, anthropogenic impacts to the Kemp's ridley population are similar to those discussed above for other sea turtle species. Sea sampling coverage in the Northeast otter trawl fishery, pelagic longline fishery, and southeast shrimp and summer flounder bottom trawl fisheries have recorded takes of Kemp's ridley turtles. Following World War II, there was a substantial increase in the number of trawl vessels, particularly shrimp trawlers, in the Gulf of Mexico where the adult Kemp's ridley turtles occur. Information from fishers helped to demonstrate the high number of turtles taken in these shrimp trawls (USFWS and NMFS, 1992). Subsequently, NMFS has worked with the industry to reduce turtle takes in shrimp trawls and other trawl fisheries, including the development and use of Turtle Excluder Devices (TEDs).

Kemp's ridleys may also be affected by large-mesh gillnet fisheries. In the spring of 2000, a total of five Kemp's ridley carcasses were recovered from the same North Carolina beaches where 277 loggerhead carcasses were found. Cause of death for most of the turtles recovered was unknown, but the mass mortality event was suspected to have been from a large-mesh gillnet fishery operating offshore in the preceding weeks. The five ridley carcasses that were found are likely to have been only a minimum count of the number of Kemp's ridleys that were killed or seriously injured as a result of the fishery interaction since it is unlikely that all of the carcasses washed ashore. It is possible that strandings of Kemp's ridley turtles in some years have increased at rates higher than the rate of increase in the Kemp's ridley population (TEWG 1998).

Status and trends of Kemp's ridley sea turtles
When nesting aggregations at Rancho Nuevo were discovered in 1947, adult female populations were estimated to be in excess of 40,000 individuals (Hildebrand 1963), but the population has been drastically reduced from these historical numbers. However, the TEWG (1998; 2000) indicated that the Kemp's ridley population appears to be in the early stage of exponential expansion. Nesting data, estimated number of adults, and percentage of first time nesters have all increased from lows experienced in the 1970's and 1980's. From 1985 to 1999, the number

of nests observed at Rancho Nuevo and nearby beaches has increased at a mean rate of 11.3% per year, allowing cautious optimism that the population is on its way to recovery. For example, data from nests at Rancho Nuevo, North Camp and South Camp, Mexico, have indicated that the number of adults declined from a population that produced 6,000 nests in 1966 to a population that produced 924 nests in 1978 and 702 nests in 1985 then increased to produce 1,940 nests in 1995 and about 3,400 nests in 1999. Estimates of adult abundance followed a similar trend from an estimate of 9,600 in 1966 to 1,050 in 1985 and 3,000 in 1995. The increased recruitment of new adults is illustrated in the proportion of neophyte, or first time nesters, which has increased from 6% to 28% from 1981 to 1989 and from 23% to 41% from 1990 to 1994.

The TEWG (1998) developed a population model to evaluate trends in the Kemp's ridley population through the application of empirical data and life history parameter estimates chosen by the TEWG. Model results identified three trends in benthic immature Kemp's ridleys. Benthic immatures are those turtles that are not yet reproductively mature but have recruited to feed in the nearshore benthic environment where they are available to nearshore mortality sources that often result in strandings. Benthic immature ridleys are estimated to be 2-9 years of age and 20-60 cm in length. Increased production of hatchlings from the nesting beach beginning in 1966 resulted in an increase in benthic ridleys that leveled off in the late 1970s. A second period of increase followed by leveling occurred between 1978 and 1989 as hatchling production was further enhanced by the cooperative program between the USFWS and Mexico's Instituto Nacional de Pesca to increase the nest protection and relocation program in 1978. A third period of steady increase, which has not leveled off to date, has occurred since 1990 and appears to be due to the greatly increased hatchling production and an apparent increase in survival rates of immature turtles beginning in 1990 due, in part, to the introduction of TEDs.

The population model in the TEWG report projected that Kemp's ridleys could reach the intermediate recovery goal identified in the Recovery Plan, of 10,000 nesters by the year 2020 if the assumptions of age to sexual maturity and age specific survivorship rates plugged into their model are correct. The TEWG (1998) identified an average Kemp's ridley population growth rate of 13% per year between 1991 and 1995. Total nest numbers have continued to increase. However, the 1996 and 1997 nest numbers reflected a slower rate of growth, while the increase in the 1998 nesting level has been much higher and decreased in 1999. The population growth rate does not appear as steady as originally forecasted by the TEWG, but annual fluctuations, due in part to irregular internesting periods, are normal for other sea turtle populations. Also, as populations increase and expand, nesting activity would be expected to be more variable.

One area for caution in the TEWG findings is that the area surveyed for ridley nests in Mexico was expanded in 1990 due to destruction of the primary nesting beach by Hurricane Gilbert. Because systematic surveys of the adjacent beaches were not conducted prior to 1990, there is no way to determine what proportion of the nesting increase documented since that time is due to the increased survey effort rather than an expanding ridley nesting range. The TEWG (1998) assumed that the observed increases in nesting, particularly since 1990, was a true increase rather than the result of expanded beach coverage. As noted by TEWG, trends in Kemp's ridley nesting even on the Rancho Nuevo beaches alone suggest that recovery of this population has begun but continued caution is necessary to ensure recovery and to meet the goals identified in the Kemp's Ridley Recovery Plan.

<u>Sea turtles in the action area</u>
There is limited information on the abundance and distribution of sea turtles in the action area. While sea turtles could enter inshore New Jersey waters through the Beach Haven Inlet, several hundred kilometers south of OCNGS, it is improbable that turtles in this area would migrate northward through the narrow intracoastal waterway to the Barnegat Bay. Thus, the Barnegat Inlet, approximately 300 m wide, is considered to be the only direct access for turtles to Barnegat Bay. A sea turtle entering Barnegat Bay must travel along narrow, shallow navigation channels and pass through the wooden support structures of three bridges in order to reach the OCNGS. While this route may seem difficult for migrating or foraging sea turtles, the presence of sea turtles on the CWS and DWS intake structures provides evidence that sea turtles do occur in the action area.

No turtles have been sighted during many years of biological sampling efforts in Barnegat Bay conducted by or for the OCNGS. These biological monitoring programs were intended to qualify and quantify the marine biota of Barnegat Bay, and were not specifically tailored to capture sea turtles. In any event, sampling occurred during all twelve months of the year, day and night, at the plant intake structures as well as the intake and discharge canals. Approximately 20,000 hours of impingement and entrainment sampling (24-54 hours/week) were conducted at the CWS intake from 1975-1985, and no turtles were observed. Additionally, in Barnegat Bay, Forked River, and Oyster Creek, otter trawl sampling was conducted, gillnet sampling (with mesh sizes of 38, 70, and 89 mm) was conducted at the surface to mid-depth, and stretch mesh (0.6 and 1.3 cm) seines sampled the entire water column in nearshore areas. From 1975-1985, nearly 3000 trawl samples, hundreds of gillnet samples, and more than 2000 seine samples were collected, but no sea turtles were captured.

The BA does list one reference of a loggerhead caught in an otter trawl during a 5-year survey of Great Bay and Little Egg Harbor (estuaries immediately south of Barnegat Bay) conducted by Rutgers University prior to 1993. While there have not been any sea turtles captured in sampling efforts in the Barnegat Bay, these studies were conducted before any turtles were captured at OCNGS. As a number of sea turtles have been observed captured at OCNGS over the last 9 years and the deepening of Barnegat Inlet has likely allowed more sea turtles to enter Barnegat Bay, the composition, numbers and distribution of sea turtles in the action area may have changed since the previous sampling efforts. It would be useful to conduct an in-water assessment of sea turtles in the action area, following the NMFS-approved in-water sampling protocol.

Stranded sea turtles occur on New Jersey beaches. Loggerheads are the most common species found stranded in New Jersey, followed by leatherbacks, Kemp's ridleys and greens. From 1980 to 1999, most of the sea turtle strandings in New Jersey coastal and estuarine waters have occurred from June to November, with September having the highest number of loggerhead and Kemp's ridley strandings, followed by August. From 1992 to 1999, 90 out of a total 313 loggerhead sea turtles stranded in New Jersey were found in Ocean County, the county in which OCNGS is located. However, data from the Sea Turtle Stranding and Salvage Network for Ocean County suggests that the majority of strandings occur on the ocean side of the barrier beaches, not in the inshore areas.

ENVIRONMENTAL BASELINE

By regulation, environmental baselines for biological opinions include the past and present impacts of all State, Federal or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process (50 CFR §402.02). The environmental baseline for this biological opinion includes the effects of several activities that affect the survival and recovery of threatened and endangered species in the action area. Within the action area, sea turtles and optimal turtle habitat may likely have been impacted by vessel collisions, previous dredging projects, fisheries, and pollution.

A potential contributor to sea turtle mortality in the action area is collisions with vessels, from both commercial and recreational sources. Fifty to 500 loggerheads and 5 to 50 Kemp's ridley turtles are estimated to be killed by vessel traffic per year in the U.S. (National Research Council 1990). Although some of these strikes may be post-mortem, the data show that vessel traffic is a substantial cause of sea turtle mortality. The Intracoastal Waterway traverses the length of Barnegat Bay, and numerous recreational boaters and commercial fishing boats travel this waterway. The Intracoastal Waterway is maintained at a depth of approximately 2 meters by the Army Corps of Engineers, but the greatest depths in Barnegat Bay of 3 to 4 meters occur along this area. As turtles may be in the area where high vessel traffic occurs, the potential for collisions with vessels transiting these waters exists.

Dredging activities have the ability to impact sea turtles by entraining and killing turtles and by disrupting their habitat. Sea turtle mortality in hopper dredging operations occurs when the turtles are sucked into the dredge draghead, pumped through the intake pipe and then killed as they cycle through the centrifugal pump and into the hopper. The depth of the Intracoastal Waterway, located in the action area, must be maintained for navigational purposes, resulting in dredging being conducted in the action area. The specific dredge used in dredging the Intracoastal Waterway is not available at the time of this consultation. However, previous dredging activities conducted to develop and maintain the channel may have impacted sea turtles. Furthermore, the Barnegat Inlet, the only tidal inlet in the vicinity of Oyster Creek which provides access to Barnegat Bay from the Atlantic Ocean (and the probable pathway for turtles moving to the OCNGS), was deepened during dredging operations in the early 1990s. Sea turtles were not documented at OCNGS until 1992, after the Barnegat Inlet was dredged, and it is likely that this deepening provided access for sea turtles to enter the action area. Thus, due to the dredging of Barnegat Inlet, sea turtles are now found in the vicinity of the OCNGS and are more likely to be impinged at the intakes. While there have been no takes documented in any dredging activities conducted in the action area, sea turtles may have been impacted by dredging operations, including direct injury or morality, the resuspension of sediments potentially containing contaminants, and the alteration of foraging habitat.

A variety of commercial and recreational fisheries occur in the action area, producing valuable input into the local economy. Commercially important finfish and shellfish species occurring in the Barnegat Bay include the American eel, alewife, bluefish, striped bass, summer flounder, winter flounder, weakfish, blue crab, horseshoe crab, and hard clam (Barnegat Bay Estuary Program 2001). Several recreational fisheries exist in the action area as well, most notably for bluefish, striped bass, summer flounder, winter flounder, weakfish, black sea bass, and tautog. Fishing gear has been found to entangle and/or hook sea turtles, which can lead to mortality if the

sea turtle cannot surface for air. Throughout their range, sea turtles have been taken in different types of gear, including gillnet, pound net, rod and reel, trawl, pot and trap, longline, and dredge gear. There have been no documented takes of sea turtles in any of the fisheries in Barnegat Bay, but it is not known to what degree the various fisheries interact with turtles. Thus, sea turtles may interact and be affected by any of these commercial or recreational fisheries.

Approximately 28% of the Barnegat Bay watershed is developed (residential, commercial, industrial, and institutional), while 46% is forested land. The Barnegat Bay supports a thriving tourist industry, with boating, fishing, swimming, and hunting being top recreational activities. The developed land around the Bay may contribute to marine pollution which may in turn impact sea turtles. Marine debris (e.g., discarded fishing line or lines from boats) can entangle turtles in the water and drown them. Turtles commonly ingest plastic or mistake debris for food.

Chemical contaminants may occur in the action area largely as a result of nonpoint source pollution. The Barnegat Bay Estuary Program has data on trace metals and radionuclides in the Barnegat Bay, but other toxic chemical contaminants may also occur in the action area including halogenated hydrocarbons and polycyclic aromatic hydrocarbons (PAHs). The Barnegat Bay estuary may be more susceptible to toxic chemical contaminants than may other estuaries because of its limited dilution capacity and flushing rate (Barnegat Bay Estuary Program 2001). These chemical contaminants may have an effect on sea turtle reproduction and survival. While the effects of contaminants on turtles is relatively unclear, pollutants may also make sea turtles more susceptible to disease by weakening their immune systems.

EFFECTS OF THE ACTION

In this section of a biological opinion, as required by the ESA and interagency section 7 regulations, NMFS assesses the direct and indirect effects of the proposed action on threatened and endangered species or critical habitat, together with the effects of other activities that are interrelated or interdependent (50 CFR §402.02). Indirect effects are those that are caused later in time, but are still reasonably certain to occur. 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). The purpose of this assessment is to determine if it is reasonable to expect the NRC's proposed action to have direct or indirect effects on threatened and endangered species that appreciably reduce their likelihood of both the survival and recovery in the wild [which is the "jeopardy" standard established by 50 CFR §402.02].

The proposed action is likely to adversely affect threatened and endangered sea turtles in four different ways: (1) impingement at either the CWS or DWS intake trash racks; (2) alteration of sea turtle distribution or sea turtle prey abundance from the thermal discharge; (3) cold stunning relating to the thermal discharge; and (4) impacts from the chlorine used at the OCNGS. Biological interactions result from disturbance of normal sea turtle foraging behavior and changes in the composition of the marine community. This Opinion assesses each of these four effects on the sea turtles' likelihood of surviving and recovering in the wild, but most of the discussion will focus on impingement, which is the greatest potential threat of OCNGS to sea turtles.

A) Impingement of Sea Turtles

Power plants with intake structures have the potential to impinge sea turtles, resulting in mortality if the turtles are not recovered within a sufficient amount of time. Both live and dead sea turtles have been found impinged at the OCNGS in the past, at both the DWS and CWS intakes. The problem with this impingement is that a turtle could be caught against the grate underwater by the current long enough to cause suffocation or drowning. Plant personnel estimated that many of the turtles that were taken at OCNGS had been impinged for up to 8 hours. In some natural situations, turtles may remain submerged for several hours. However, stress dramatically decreases the amount of time a turtle can stay submerged. For example, trawl times for shrimpers in the southeast are limited by regulation to 55 minutes in the summer months and 75 minutes in the winter months, due to the fact that there is a strong positive correlation between tow time and incidence of sea turtle death (Henwood and Stuntz 1987, Stebenau and Vietti 2000). Under conditions of involuntary or forced submergence, sea turtles maintain a high level of energy consumption, which rapidly depletes their oxygen store and can result in large, potentially harmful internal changes (Magnuson et al. 1990). Those changes include a substantial increase in blood carbon dioxide, increases in epinephrine and other hormones associated with stress, and severe metabolic acidosis caused by high lactic acid concentrations. In forced submergence, a turtle becomes exhausted and then comatose; it will die if submergence continues. Physical and biological factors that increase energy consumption, such as high water temperature and increased metabolic rates characteristic of small turtles, would be expected to exacerbate the harmful effects of forced submergence. Other factors, such as the level of dissolved oxygen in the water, the activity of the turtle and whether or not it has food in its stomach, may also affect the length of time it may stay submerged. It is likely that sea turtles impinged on the intake trash bars are stressed, and these conditions may increase the turtles' susceptibility to suffocation or drowning.

If a sea turtle is impinged on the intake trash bars, drowning will be the most likely cause of mortality or injury, but the sea turtle could also become injured by the operation of the facility. Debris are cleaned from the intake trash bars by a trash rake which is moved on a track from one bay to the next. The rake, a horizontal array of large curved tines, is lowered down into the bay to remove debris from the intake gratings. When the rake reaches the desired depth, the tines are deployed, curving downward to penetrate through the grate before the rake is raised. This process could cause serious injury to a turtle. Scrapes on a turtle's carapace could also result from interactions with the intake trash bars, or during rescue and retrieval by OCNGS personnel.

In addition to injury and mortality, impingement at the OCNGS intake could result in the interruption of migration and the eventual loss of nesting opportunities. Sea turtles migrate to northeastern waters when the waters warm in the late spring and early summer, returning south in the late fall. While turtles may be in the action area for foraging purposes, it is possible that turtles are migrating through the area in the spring on their way to more suitable foraging habitats in the Northeast, or in the fall on their way to overwintering areas. Thus, if impingement impedes this migration, this would affect typical sea turtle migration and/or foraging patterns. Most of the sea turtles found at OCNGS are juveniles and are not partaking in nesting. However, if impingement results in mortality, these animals would not nest in the future and would not subsequently contribute to the population.

Debris floating on the surface could make it more difficult to spot a turtle below, particularly if the turtle was flush against the grating. A small amount of debris may not be enough to block the flow and necessitate use of trash rakes, but could hide a turtle. In addition, visibility at the intake

bays, which are 15 (DWS) to 18 (CWS) feet deep, is only 2-3 feet. Although at least one of the impinged turtles was found alive with its head out of the water, a turtle that is impinged at depth could remain out of sight until the trash rake was lowered to it. It is possible that a turtle could swim into the intake bay, encounter the grating, and swim down along the grating to a depth below the view of surface observers. If a turtle is feeding on the bottom of the intake canal, its first encounter with the intake grating could be at depth.

It is unclear why sea turtles enter the Forked River and encounter the OCNGS intake structures. Turtles could be attracted to the intake screens when prey items such as blue crabs and horseshoe crabs are gathered there. In 1992, one loggerhead turtle was recaptured 2 days after it was released into the discharge canal. This suggests that the turtle was attracted either to the ambient conditions in the south fork of the Forked River or to the conditions at the intake trash racks. Attractive features may be associated with the discharge as well as the intake. The warm water discharge may increase the distribution of prey species to the area, and returns of live entrained organisms or dead fish and other material dumped from the traveling screens may provide food for the turtles or scavenging prey species.

The diversion of the south fork of the Forked River may also create conditions which attract turtles to the OCNGS and therefore increase the likelihood of impingement. When the plant is operational, all flow in the south fork is diverted into the CWS and DWS intakes, so it is possible that impingements of turtles at the OCNGS could be the result of routing the entire south fork rather than of an attraction at the intake screens. The diversion also represents a reversal of flow in the south fork.

Though sea turtles are known to use New Jersey's coastal waters, no turtles were observed in Barnegat Bay in 20 years of sampling conducted by OCNGS up to 1992 and no turtles were observed taken at the plant during the first 23 years of operation. However, the frequency and efficiency of monitoring the intakes prior to 1992 has not been determined. Incidental captures of sea turtles at OCNGS CWS and DWS cooling water intakes were documented in June of 1992 by OCNGS Environmental Controls personnel and reported to NMFS according to reporting procedures established through informal consultation conducted between OCNGS, NRC, and NMFS. Between June 1992 and July 1994, 9 sea turtle impingements occurred at the OCNGS intake trash bars, including 5 loggerheads (1 recapture) and 4 Kemp's ridleys. Three of the loggerheads and 1 of the Kemp's ridleys were recovered alive. The remaining turtles were recovered dead from the intake trash bars, but the cause of death was not established for all of the dead animals. From September 1995 to the present, 9 additional sea turtle impingements have been documented at the OCNGS intake trash bars, including 3 loggerheads, 4 Kemp's ridleys, and 2 greens. Thus, there have been 18 total observed takes at the OCNGS since 1969, including 8 Kemp's ridleys, 8 loggerheads (which includes 1 recapture), and 2 greens. The details of those takes are outlined in Appendix I.

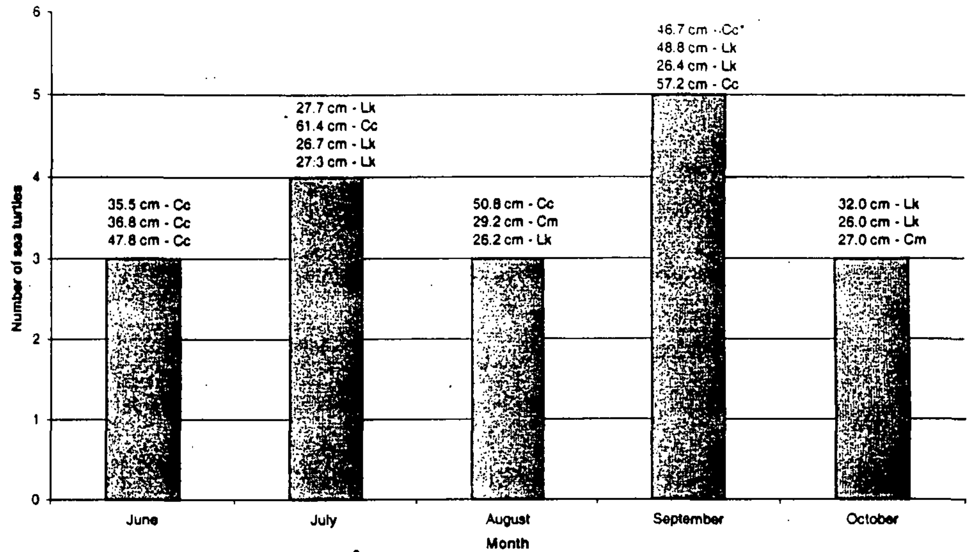
The number of sea turtles collected at the OCNGS CWS and DWS intakes per year has ranged from zero (from 1969 to 1991, 1995, 1996) to a maximum of five in 2000, with an average of slightly less than two turtles incidentally captured during any single year since 1992. The number of loggerhead takes has ranged from zero to two (in 1992, 1994, 2000) a year, and the number of Kemp's ridley annual takes has been from zero to two (in 1994, 2000). The number of green sea turtles collected annually on the intakes ranged from zero to two (in 2000).

As previously noted, the frequency and effectiveness of monitoring the intake trash bars prior to the first turtle impingement in 1992 is uncertain, and this may have played a role in the pattern of sea turtle impingements. However, the operation of the OCNGS has not changed appreciably since 1969, suggesting that the onset of turtle captures in 1992 is due to higher numbers of sea turtles in the project area. The deepening of Barnegat Inlet and associated waterway channels was completed immediately prior to 1992, when incidental captures of sea turtles began to occur at OCNGS. As the deepening of this inlet provided for a greater volume of water and tidal range in the Barnegat Bay and in the vicinity of Oyster Creek, a greater number of turtles may have been able to enter the Bay as a result of this deepening. If maintenance dredging of the Intracoastal waterway and Barnegat Inlet, which increases water volume, makes the Bay more accessible to turtles, the frequency of impingements at OCNGS may increase after each dredging episode and decrease as the Bay fills with sediment. While difficult to quantify, an increase in the occurrence of oceanic fronts may have also contributed to an increase in turtles in Barnegat Bay, as Polovina et al. (2000) suggest that turtles use oceanic fronts as migratory and foraging habitat. If a greater number of turtles are in the offshore New Jersey waters as a result of the oceanic patterns and they migrate through the Barnegat Inlet, more sea turtles may be found in the action area. Sea turtles may enter the Barnegat Bay with an increase in waves, winds and tidal prism. The yearly fluctuations may also be attributable to biological factors such as the abundance of prey organisms (e.g., blue crabs, horseshoe crabs) in the vicinity of Oyster Creek.

While four turtles were collected at OCNGS in 1994, more turtles have been captured in 2000 than in any other year and this number is much higher than the average since 1992 (approximately 2 turtles/year). Physical and biological factors may have played a role attracting more turtles to the vicinity of OCNGS in 2000, but there is no information on the documentation of more turtles in the action area or the physical or biological parameters that may have cause such an increase during this time period. Therefore, it is unclear why more sea turtles were captured in 2000 than in previous years.

All of the turtles have been collected at OCNGS from June through late October. This confirms the presumption that loggerhead, Kemp's ridley, and green sea turtles occur in the action area during this time period and that the impacts of the OCNGS on listed species will be higher during June through early November. Most of the turtles have been collected in September (including the recapture), followed by July (Figure 2). It does not appear that there is any pattern in the species caught in the different months. With the exception of June, when only loggerheads were captured, at least two different species were caught in any given month. While it has been thought that turtles are less active at night, thus increasing the likelihood of impingement at night, the results at OCNGS do not support this theory. There does not appear to be any difference in the time of day for which turtles were collected from 1992 to the present. However, these results should be interpreted with caution because in many of the cases the turtles could have been present at the intake structure between 3 to 8 hours.

FIGURE 2. Seasonal Occurrence, Species, and Straight Carapace Length of Sea Turtles found at OCNGS Intakes



*This turtle was captured twice in the month of September.

The loggerhead turtles incidentally captured at OCNGS had an average straight carapace length (SCL) of 47.9 cm. The incidentally captured eight Kemp's ridleys and two green turtles had an average SCL of 30.1 cm and 28.1 cm, respectively. Most of the sea turtles likely to occur in the project area are too large to pass through the intake trash bars, which are constructed with 6.6 cm wide openings. All of the turtles captured at OCNGS thus far have measured at least 26 cm SCL. The BA states that any sea turtle that is smaller than the trash bar opening would pass through the CWS intake trash bars and be transported safely to the water via the same traveling screen system that returns entrained fish and other small organisms. It is unlikely that small turtles will be in the vicinity of the OCNGS, but if they were entrained in the facility, they could be subject to stress or drowning. The DWS intake trash bars are not equipped with traveling screens to return entrained organisms to the water.

That there have been slightly more Kemp's ridleys caught at OCNGS than loggerheads is noteworthy, as there are thought to be more loggerheads than Kemp's ridleys in New Jersey waters. Kemp's ridleys could be more likely to become impinged in the intake structures due to their physiology and behavioral characteristics. Swimming efficiency is likely related to the size of a turtle, with larger turtles having a stronger swimming ability than smaller turtles. As such, it is possible that because the Kemp's ridleys and greens found impinged at OCNGS are generally smaller than the loggerheads, they were not able to effectively escape the intake velocity. However, little information exists about the swimming behavior of turtles which can be used to make predictions about behavior at intake gratings or the ability to swim against various current velocities. Of the 10 live turtles found at OCNGS from 1992 to the 2000, two loggerheads (36.8 cm SCL and 50.8 cm SCL) were swimming freely upstream of the CWS intake bars. Of the 18 turtles found impinged at OCNGS, 56% (n=10) of these turtles were alive at the time of incidental capture (Appendix I). Of the eight loggerheads taken, 75% (n=6) were alive at the

time of the take, while only 38% (n=3) of the eight Kemp's ridleys were taken alive. One of the two captured green turtles was alive. Nine of the ten live turtles were successfully released into the ocean, with the remaining turtle anticipated to be released in the near future. The ability of a given turtle to swim against the current at either the CWS or DWS intake and the condition at time of capture could depend on the species, size, relative health of each individual, or the particular conditions associated with each take (e.g., water temperature, duration of submergence time, etc.). Kemp's ridleys cannot survive underwater as long as other sea turtle species, as they have been found to drown faster in trawl nets compared to other species (Magnuson et al. 1990). A turtle weakened by disease or injured by a boat strike would be more susceptible to impingement if the velocity at the intake is a factor in the likelihood of impingement.

There is currently no available data on the distribution of loggerheads, Kemp's ridleys and greens in the action area. It is possible that small sea turtles occur in the vicinity of Oyster Creek and do not become impinged in the intake structure. There were no greens captured at OCNGS until 1999, when 1 was taken in 1999 and another in 2000. The green turtles were similar in size to the Kemp's ridleys that were taken. It is unclear why green sea turtles are being incidentally captured with greater frequency than in previous years.

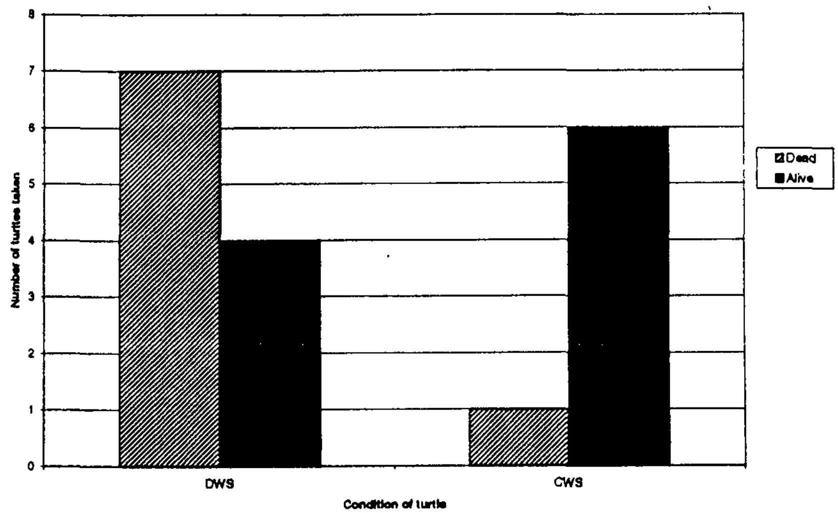
The cause of death for many of the turtles found at OCNGS is difficult to determine. Necropsy results are only available for three turtles, the two dead loggerheads and one Kemp's ridley. The cause of death for the loggerhead captured on June 25, 1992, was determined to be from boat propeller wounds, before impingement at the OCNGS. The Kemp's ridley captured on October 17, 1993, was found to have drowned at the DWS trash bars, given the lack of obvious trauma. This turtle was found to have no stomach contents, which is not surprising as turtles are expected to be migrating during this time of year. The necropsy performed on the loggerhead captured on July 6, 1994, concluded that the turtle did not die at the OCNGS due to the level of decomposition, apparent bacterial infection, and good condition of the lungs. However, the presence of blue crabs in both the esophagus and stomach suggest that this turtle was actively feeding prior to death. While necropsies have not been performed on the additional four dead Kemp's ridleys, the specimens appeared to be fresh dead, leading to speculation that the impingement at the OCNGS was responsible, at least in part, for the mortalities. The one dead green turtle was also captured in fresh condition, also suggesting that drowning was the cause of death. However, it is possible that the documented lethal take at OCNGS could be an overestimate of the number of turtles that were actually killed by the facility.

While there were more sea turtles captured at OCNGS in 2000 than in any other year, four of the five turtles were found alive. These turtles were (or are anticipated to be) released in apparent good condition into the Atlantic Ocean. With frequent and effective monitoring, sea turtles incidentally captured at either the DWS or CWS intake can be successfully released.

The specific intake location could be a factor in the number of turtles incidentally captured as well as the condition of the turtle. Of the eighteen incidental captures from 1992 to 2000, eleven (61%) have occurred at the DWS intake and seven (39%) at the CWS intake (Figure 3). There has also been a greater percentage of takes at the DWS in recent years; five of seven turtles (71%) have been found at the DWS intake since 1999, whereas six of eleven turtles (55%) were found there before 1999. However, the reason for this slight increase is unknown, as there has been no operational or mechanical change at either intake since that time which would explain the increase in takes at the DWS intake. It is also noteworthy that more sea turtles have been found dead than alive at the DWS (64%) as compared to those captured at the CWS (14%;

Figure 3). However, this could be attributable to a number of variables. For example, more Kemp's ridleys (and greens) have been found at the DWS and they may be more susceptible to drowning or less able to swim away from the high intake velocity given their small size in these waters. Additionally, the intake velocity at the DWS is higher than the CWS intake velocity, drawing in more water, which could contribute to a higher degree of mortality.

FIGURE 3. Condition and location of turtles found at OCNGS intakes



During normal operation at 100% power, the two dilution water pumps typically withdraw a total of 1968 m^3/min from the intake canal and the four circulating water pumps withdraw a total of an additional 1740 m^3/min. The cross sectional area of the DWS intake is smaller than that of the CWS intake, resulting in a higher average through-screen velocity at the DWS than at the CWS intake. The DWS pumps typically withdraw about 53% of the water pumped from the intake canal, while the DWS pumps withdraw approximately 47%. The ratio of water intake levels are similar to the ratio of turtle takes between the DWS and CWS. However, there is no information on the relative effects of suction at the trash racks on a turtle-shaped object for different current velocities. It may be much more difficult for a turtle to remove itself from a position parallel to the trash rack than from a perpendicular position at the surface.

The floating debris/ice barrier upstream of the intake structures was designed to divert floating debris away from the CWS intake and toward the DWS intake, A turtle that swims or drifts on the surface toward the OCNGS intakes may be turned towards the DWS by the floating wooden debris/ice barrier. The orientation of the barrier may result in turtles at the surface being funneled toward the DWS. However, there are gaps on either end which a turtle could easily swim through and the barrier only extends 2 feet below the surface, so a healthy turtle could easily swim under the barrier and turn left towards the CWS intake.

The intake velocity, amount of water withdrawl, and the floating debris/ice barrier are potential factors in the higher number of takes at the DWS as compared to the CWS. The differences between DWS and CWS could also be attributable to the turtle species. From 1992 to 2000, five

of the eight loggerheads (63%) captured at OCNGS have been retrieved from the CWS intake, while only two of the eight Kemp's ridleys (25%) and neither of the green turtles have been found at the CWS intake. The biological characteristics of the individual and/or species (i.e., size, strong swimmer) could determine the resultant intake. The loggerheads incidentally captured have been generally larger than the Kemp's ridleys or greens, and the larger size of the loggerheads could result in more efficient swimming ability, allowing the animal to move around the floating ice/debris barrier and end up at the CWS intake. If Kemp's ridley and green turtles were found close to the surface and lacking the swimming ability or strength to dive beneath the floating ice/debris barrier, they would be channeled to the DWS intake. There is no information to suggest that one sea turtle species would be more likely to be at the surface than another, and whether these sea turtles are found on the surface would depend on the activity. These species' prey are typically found on the bottom (e.g., crustaceans, marine grasses), which would suggest that they would not be on the surface if they were foraging. If turtles are migrating they could be found near the surface. In water depths greater than 15 meters in New York, young Kemp's ridleys were found to spend the majority of their time in the upper portions of the water column and time spent on the surface increased with water depth (Morreale and Standora 1990). Barnegat Bay itself is relatively shallow, 1.2 m deep on average, and the depths at the intake bays are only approximately 4 to 6 meters deep.

B) Impacts of thermal discharge

Heated condenser cooling water discharged from the CWS and ambient temperature intake canal water discharged from the DWS meet and mix in the discharge canal and are returned to Barnegat Bay via this canal. This process results in heated discharge water mixing with the ambient water and elevating the normal water temperatures. Sea turtles may be affected directly or indirectly by these elevated temperatures, but it is important to note that no sea turtles have been observed in the vicinity of the OCNGS discharge.

The water flowing from the DWS and CWS is discharged through separate structures. However, sea turtle entrainment in the DWS and CWS discharge structures is unlikely. The discharge velocities are high (65-95 cm/sec), likely precluding a sea turtle from staying in the vicinity of the discharge for a significant amount of time. Given the velocity associated with these discharges, a sea turtle would have to actively swim against the current and stay in the vicinity of the discharge; this situation is unlikely to occur at OCNGS. The more notable impacts on sea turtles from the DWS and CWS discharges are likely due to the elevated temperatures of the discharges. The temperature rise of the CWS discharge is typically about 11° C above ambient canal temperatures, while the DWS discharge is approximately 5.6° C above ambient water temperatures when two dilution pumps are operating.

While sea turtles will not likely be killed by these elevated temperatures, temperature rises may affect normal distribution and foraging patterns. The thermal effluent discharged from the plant into Oyster Creek may represent an attraction for turtles. If turtles are attracted into Oyster Creek by this thermal plume, they could remain there late enough in the fall to become cold-stunned when they finally travel into Barnegat Bay at the start of their southern migration. 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 concentrated around the heated discharge or in surrounding waters heated by the discharge (e.g., Oyster Creek or Barnegat Bay) and move outside of this plume into cooler waters (approximately less than 8-10° C), they could become cold stunned.

Existing data from OCNGS and other 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. Data reported by the STSSN indicate that cold-stunning has occurred around mid-November in New York waters. No incidental captures of sea turtles have been reported at the OCNGS later than October, suggesting that sea turtles leave this site before cold-stunning would occur.

However, cold shock mortalities of fish have occurred at OCNGS when water temperatures have decreased in the fall. The number and severity of these events have been reduced as a result of the operation of the two dilution pumps in the fall, when ambient water temperatures began to drop, to decrease the attractiveness of the discharge canal as overwintering habitat. As mentioned, cold stunning of sea turtles has not been documented at OCNGS, but the measures to reduce cold shock mortalities of fish would also help reduce the potential for cold stunning of sea turtles.

While cold stunning could still occur given the heated discharge and the water temperatures in New Jersey during certain times of the year (e.g., less than 10° C), the BA identifies certain aspects of the OCNGS discharge that may make cold stunning less likely to occur. For example, the area where sea turtles may overwinter (and entertain acceptable water temperatures) is limited to the small area around the condenser discharge, prior to any mixing with the DWS flow. Winter water temperatures in the discharge canal, downstream of the area where the DWS and CWS flows mix, routinely fall below 7.2° C. These temperatures in the discharge canal would not be suitable for sea turtle survival. Sea turtles generally are found in water temperatures greater than 10° C, but have occasionally been documented in colder waters. For example, in March 1999, a live loggerhead sea turtle was observed taken on a monkfish gillnet haul in North Carolina, in a water temperature of 8.6° C. In any event, during the winter, the area where the water temperatures would be suitable for sea turtles is small and localized.

Furthermore, the current is strong at the site of these discharges (65-95 cm/sec) and it is improbable that turtles would fight the current long enough to remain in the warmest portions of the effluent. Turtles that stay in this area would most likely have to undergo continuous swimming activity, and the food resources in this area would also have to be sufficient to maintain such activity. During the winter, it is unlikely that the prey will be sufficient to maintain this level of activity, but data are not available on the amount of prey in the discharge area in the winter. It is also relatively unlikely that sea turtles would be foraging in the action area during the colder months. Turtles present in the vicinity of Oyster Creek may not be foraging during the fall (or in the winter if they are present in the area), but instead, sea turtles are likely undergoing seasonal migrations during this time. Dr. Steve Morreale noted, in the report of the necropsy performed on the Kemp's ridley impinged on October 17, 1993, that the lack of food in the gut is typical of sea turtles that he has seen at that time of the year and is indicative of a behavioral change prior to migrating southward.

The impacts of the thermal plume in Barnegat Bay appear to be on the surface and relatively small, thus reducing the potential negative affect to sea turtles. The cooling water discharged from OCNGS has been studied on several occasions to determine the distribution, geometry, and dynamic behavior of the thermal plume (OCNGS 2000). While the discharge temperature near OCNGS is high, the turbulent dilution mixing produces rapid temperature reductions. Little mixing with the heated discharge and ambient water occurs in Oyster Creek from the site of the discharge to the Bay, because of the relatively short residence time and the lack of turbulence or

additional dilution. However, in Barnegat Bay, temperatures are rapidly reduced when mixing with ambient temperature Bay water occurs as well as heat rejection into the atmosphere. In Barnegat Bay, the plume occupies a relatively large surface area (estimated to be less than 1.6 km in an east-west direction by 5.6 km in a north-south direction, under all conditions) and in general, elevated temperatures do not extend to the bottom of the Bay except in the area immediately adjacent to the mouth of Oyster Creek. While the plume in Barnegat Bay is on the surface, it may impact sea turtles as they are coming up for air. However, turtles should be able to move around the plume into other areas of the Bay.

The thermal discharges from OCNGS may influence the distribution and survival of sea turtles' primary prey resources. Blue crab and horseshoe crab are found in the canal, generally during the warmer months, but the effect of the heated effluent on the distribution of these species is uncertain. Crustaceans may move elsewhere when conditions are unfavorable (e.g., elevated water temperatures), but there is no information at this time suggesting that this has occurred at OCNGS. It is probable that when sea turtles are foraging, the heated effluent will not have as great of an impact on the turtles (i.e., from cold stunning) as it would in the winter. Furthermore, the New Jersey Department of Environmental Protection evaluated the impact of the OCNGS thermal plume on Barnegat Bay and concluded that the effects on fish distribution and abundance were small and localized with few or no regional consequences (Summers et al. 1989 in OCNGS 2000). Thus, it does not appear that the preferred prey of loggerhead, Kemp's ridleys, and greens are impacted to a great extent by the thermal discharge of the OCNGS.

C) Impacts of chlorine used at the OCNGS

Low level, intermittent chlorination is used to control biofouling in the OCNGS service water system and circulating water systems. The main condenser cooling water is chlorinated for approximately two hours per day. The permitted maximum daily concentration of chlorine discharge is 0.2 mg/l or a maximum daily chlorine usage of 41.7 kg/day, as limited by the New Jersey Pollutant Discharge Elimination System permit for the OCNGS. According to the BA, the chlorine demand in the main condenser discharge consumes almost all remaining free chlorine and results in very little chlorine being released to the discharge canal (approximately 0.1 mg/l). The DWS does not have any chlorine discharges.

Chemical contaminants have been found in the tissues of sea turtles from certain geographical areas. While the effects of chemical contaminants on turtles are relatively unclear, they may have an effect on sea turtle reproduction and survival. There is no information available on the effects of chlorination on sea turtles. It is also unknown as to whether the sea turtles impinged at OCNGS had appreciable levels of chlorine in their issues. The necropsies conducted on the sea turtles found at the OCNGS did not assess the levels of contaminants in the tissue.

The chlorine discharge may have some level of impact on sea turtles, but the effect is unquantifiable at this time. In any event, there is only a small quantity of chlorine applied to the CWS, the residual chlorine levels in the condenser discharge are near zero, and the condenser discharge is combined with unchlorinated DWS flow before entering the discharge canal. Any level of chlorine in the water would be further diluted as the discharge canal mixes with the Barnegat Bay, the area where sea turtles would most likely be present. This minimal level of chlorination in the discharge canal and in the proximity to the greatest number of sea turtles in the action area results in little potential impact to sea turtles.

D) Summary of effects

The greatest risk to sea turtles from the continued operation of the OCNGS is due to impingement at the DWS and CWS intakes, resulting in injury or mortality. Sea turtles that are impinged at the intakes may drown if they have been previously injured, are diseased or incapacitated, or if they are not removed from the intakes before they drown. The amount of time a sea turtle may remain underwater varies on a number of parameters, including the species of sea turtle, size and condition of the animal, and water temperature. In any event, sea turtles, both alive and dead, may become impinged at the OCNGS intakes. Turtles may also be injured by the process of debris cleaning by the trash rake or they may be affected by the heated discharge or chlorine levels in the water.

Loggerhead sea turtles

Like other sea turtles, loggerheads demonstrate slow growth, delayed maturity, and extended longevity to allow individuals to produce more offspring. As discussed in the Status of the Species section, more offspring may compensate for the high natural mortality in the early life stages; i.e., mortality rates of eggs and hatchling are generally high and decrease with age and growth. The risks of delayed maturity are that annual survival of the later life stages must be high in order for the population to grow. Population growth has been found to be highly sensitive to changes in annual survival of the juvenile and adult stages. Crouse (1999) reports, "Not only have large juveniles already survived many mortality factors and have a high reproductive value, but there are more large juveniles than adults in the population. Therefore, relatively small changes in the annual survival rate impact a large segment of the population, magnifying the effect."

The loggerhead sea turtles in the action area are likely to represent differing proportions of the four western Atlantic subpopulations. Although the northern breeding population produces about 9 percent of the total loggerhead nests, they comprise more of the loggerhead sea turtles found in foraging areas from the northeastern U.S. to Georgia. Twenty-five to 59 percent of the loggerhead sea turtles in this area are from the northern breeding population (Sears 1994, Norrgard 1995, Sears et al. 1995, Rankin-Baransky 1997, Bass et al. 1998). As described in the Status of the Species section, the TEWG (2000) estimated that there was a mean of 6,247 northern subpopulation nests in 1989 to 1998, translating into approximately 3,800 nesting females. This subpopulation may be experiencing a significant decline due to a combination of natural and anthropogenic factors, demographic variation, and a loss of genetic viability. It is likely that a large number of the loggerheads which may occur in the action area may originate from the northern breeding population. Loggerheads originating from the southern breeding population could also be in the vicinity of the OCNGS.

A total of 8 loggerhead impingements occurred at the OCNGS intake trash bars between January 1992 and December 2000, with an average of approximately 1 take per year. The maximum number of loggerheads taken annually was 3, but one of these takes was a recapture. Two loggerheads were captured in 2 separate years. The maximum number of loggerhead mortalities in any given year was 1, with an average of 0.2 mortalities per year over the 9 years where sea turtles were taken (range 0 to 1). Necropsy reports are not available for all the loggerhead mortalities, so it is not possible to adjust this rate to reflect mortalities which may have occurred prior to impingement. Given the level of previous impingement at the OCNGS, the status and distribution of loggerhead sea turtles, and the proposed operation of the facility with the mitigation measures in place, the anticipated loggerhead take associated with the continued operation of the OCNGS is five animals per year, with a maximum of two lethal.

NMFS anticipates that no more than five loggerheads (no more than two lethal) will be taken each year as a result of the continued operation of the OCNGS. Thus, the operation of the OCNGS could result in the take of up to 100 loggerheads (40 lethal) over the next twenty years. The death of two loggerheads every year would represent a loss of less than 0.05 percent of the estimated number of nesting females in the northern subpopulation. These are conservative estimates, however, since the loss of loggerhead turtles during the proposed activity are not likely limited to adult females, the only segment of the population, or subpopulation, for which NMFS has any population estimates. Although unlikely to occur, a worse case scenario could occur over the next twenty years if the anticipated 40 loggerheads killed were juvenile females from the northern subpopulation.

Given the low numbers of anticipated take (even under a worst case scenario) and the current loggerhead subpopulation sizes, the operation of the OCNGS is not expected to have a detectable effect on the numbers or reproduction of the affected subpopulations. Therefore, it is not expected to appreciably reduce the likelihood of survival and recovery of the species.

Kemp's ridley sea turtles
A total of 8 Kemp's ridley impingements occurred at the OCNGS intake trash bars between January 1992 and December 2000, with an average of approximately 1 take per year. The maximum number of Kemp's ridleys taken annually was 2, which was reached in 2 separate years. The maximum number of Kemp's ridley mortalities in any given year was 2, with an average of 0.6 mortalities per year over the 9 years where sea turtles were taken (range 0 to 2). Necropsy reports are not available for all the Kemp's ridley mortalities, so it is not possible to adjust this rate to reflect mortalities which may have occurred prior to impingement. Given the level of previous impingement at the OCNGS, the status and distribution of Kemp's ridley sea turtles, and the proposed operation of the facility with the mitigation measures in place, the anticipated Kemp's ridley take associated with the continued operation of the OCNGS is four animals per year, with a maximum of three lethal.

The biology of the Kemp's ridley also suggests that losses of juvenile turtles can have a magnified effect on the survival of this species. NMFS anticipates that no more than four Kemp's ridleys (no more than three lethal) will be taken each year as a result of the continued operation of the OCNGS. Thus, the operation of the OCNGS could result in the take of up to 80 Kemp's ridleys (60 lethal) over the next twenty years. The death of three Kemp's ridleys every year would also represent a loss of less than 0.1 percent of the population. As with loggerheads, these are conservative estimates since the loss of Kemp's ridleys during the proposed activity is not likely limited to adult females, the only segment of the population for which NMFS has any population estimates. Although unlikely to occur, a worse case scenario could occur over the next twenty years if all of the 60 Kemp's ridleys killed were juvenile females.

Given the low numbers of anticipated take (even under a worst case scenario) and the current population size, this loss is not expected to have a detectable effect on the numbers or reproduction of the affected population. Therefore, the operation of the OCNGS is not expected to appreciably reduce the likelihood of survival and recovery of the species.

Green sea turtles
A total of 2 green turtle impingements occurred at the OCNGS intake trash bars between January 1992 and December 2000, with an average of 0.2 takes per year. However, these two takes have

occurred since 1999. The maximum number of greens taken annually was 1, and the maximum number of green turtle mortalities in any given year was 1, with an average of 0.1 mortalities per year over the 9 years where sea turtles were taken (range 0 to 1). Necropsy reports are not yet available for the green turtle mortality, so it is not possible to adjust this rate to reflect mortality which may have occurred prior to impingement. Given the level of previous impingement at the OCNGS, the status and distribution of green sea turtles, and the proposed operation of the facility with the mitigation measures in place, the anticipated green turtle take associated with the continued operation of the OCNGS is two animals per year, with a maximum of one lethal.

Population estimates for the western Atlantic green sea turtles are not available. However, nesting beach data corrected on index beaches since 1989 have shown a general positive trend. NMFS anticipates that less than two greens (no more than one lethal) will be taken each year as a result of the continued operation of the OCNGS. Thus, the operation of the OCNGS could result in the take of up to 40 greens (20 lethal) over the next twenty years. At this time, the effects of the lethal incidental take of one green sea turtle a year on the population is not known, but this level of take is not likely to represent a significant loss to the population. Although unlikely to occur, a worst case scenario could occur over the next 20 years if all of the 20 green sea turtles killed were juvenile females. Given the low numbers of anticipated take (even under a worst case scenario) and the estimated population size, this loss is not expected to appreciably reduce the likelihood of survival and recovery of the species.

Based on the above rationale, NMFS anticipates that no more than five loggerheads (no more than two lethal), four Kemp's ridleys (no more than three lethal), or two greens (no more than one lethal), will be taken each year as a result of the operation of the OCNGS. To ensure that the analysis of effects in this biological opinion captures the long-term effects of this recurring activity, NMFS assumes that the operation of the OCNGS will occur over the next twenty years, from 2001 to 2021. The impacts to the species and long term anticipated incidental take will be evaluated on this time frame. Thus, the operation of the OCNGS could result in the take of up to 100 loggerhead (40 lethal), 80 Kemp's ridley (60 lethal), or 40 green (20 lethal) sea turtles over the next twenty years.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future state, tribal, local or private actions that are reasonably certain to occur within the action area considered in this biological opinion. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Natural mortality of sea turtles, including disease (parasites), predation, and cold-stunning, occurs in mid-Atlantic waters. In addition to impingement in the OCNGS intakes, sources of human-induced mortality and/or harassment of turtles in the action area include incidental takes in state-regulated fishing activities, vessel collisions, ingestion of plastic debris, and pollution. While the combination of these unrelated, non-federal activities in Barnegat Bay may affect populations of endangered and threatened sea turtles, preventing or slowing a species' recovery, the magnitude of these effects is currently unknown.

NMFS believes that the fishing activities in Barnegat Bay will continue in the future, and as a result, sea turtles will continue to be impacted by fishing gear used in the action area. Throughout their range, sea turtles have been taken in different types of gear, including gillnet,

pound net, rod and reel, trawl, pot and trap, longline, and dredge gear. Thus, it is likely that commercial and recreational fisheries in the action area will continue to impact sea turtles, albeit to an unknown extent.

Commercial and recreational vessels colliding with sea turtles will also continue in the future, and sea turtles will continue to be injured or killed from these interactions. Fifty to 500 loggerheads and 5 to 50 Kemp's ridley turtles are estimated to be killed by vessel traffic per year in the U.S. (National Research Council 1990). Although some of these strikes may be post-mortem, the data show that vessel traffic is a substantial cause of sea turtle mortality. As turtles will likely be in the area where high vessel traffic occurs, the potential for collisions with vessels transiting these waters exists. The Marine Mammal Stranding Center in Brigantine, New Jersey, reports an increase in the number of turtles hit by boats in New Jersey inshore waters, as determined from sea turtle stranding records.

Twenty-eight percent of the land around Barnegat Bay is developed. In the future, a larger amount of the watershed will likely be developed because Barnegat Bay supports a thriving tourist industry and more individuals are moving to the coast in general. An increase in boating, fishing, and general use of the Bay is also likely to occur. With this increase in development and utilization of the Bay, there is a greater potential for debris and pollutants to enter the waters of the action area. Sea turtles will continue to be impacted by pollution in the Bay and any increase in debris or pollutants would exacerbate this effect. Marine debris (e.g., discarded fishing line or lines from boats) can entangle turtles in the water and drown them. Turtles commonly ingest plastic or mistake debris for food. Stormwater runoff and other sources of nonpoint source pollution may result in the waters containing chemical contaminants. The Barnegat Bay estuary may be more susceptible to toxic chemical contaminants than may other estuaries because of its limited dilution capacity and flushing rate (Barnegat Bay Estuary Program 2001). Chemical contaminants may have an effect on sea turtle reproduction and survival, but the impacts are still relatively unclear.

INTEGRATION AND SYNTHESIS OF EFFECTS

Sea turtles are known to use New Jersey's coastal waters. While loggerhead, Kemp's ridley and green sea turtles are known to occur in the action area, there has not been a recent study determining the distribution or abundance of turtles in Barnegat Bay, and the use of the action area by sea turtles has probably changed over the past 30 years. This theory can be substantiated by the level of documented impingements occurring at the OCNGS intake structures. From 1969 to 1992, there were no sea turtles observed captured at OCNGS. However, since 1992, 18 sea turtles have been impinged at either the CWS or the DWS intake structures of the OCNGS, including 8 Kemp's ridleys, 8 loggerheads (which includes 1 recapture), and 2 greens. This apparent increase in the number of sea turtles impinged at the OCNGS since 1992 has been explained by the deepening of Barnegat Inlet, the likely path for sea turtles entering Barnegat Bay from the Atlantic Ocean. As the depth of this inlet will continue to allow sea turtles to enter the action area, sea turtle impingement is expected in the future.

The operation of the OCNGS is likely to result in the lethal and non-lethal take of loggerhead, Kemp's ridley and green sea turtles. The monitoring measures and consistent use of resuscitation techniques employed by the OCNGS will ensure that these turtle takes are observed and reported, and the diligent implementation of these procedures and prompt discovery of impinged turtles may likely serve to capture more sea turtles alive than dead.

In the past, the maximum number of sea turtles taken annually was 5 (in 2000), and the maximum number of turtle mortalities in any given year was 3 (in 1994), with an average of 0.9 mortalities per year over the 9 years where sea turtles were taken (range 0 to 3). Of the 18 turtles found impinged at OCNGS, 10 of these turtles were alive at the time of the incidental capture. Most of the turtles found alive were loggerheads (6 of the 10). Necropsy reports are not available for all the turtle mortalities, so it is not possible to adjust the mortality rate to reflect mortalities which may have occurred prior to impingement. While two of the three turtles for which necropsies were performed were assumed to have died prior to impingement, it is not appropriate to apply this rationale to the rest of the dead turtles impinged at OCNGS.

The thermal discharge from the OCNGS may also directly and indirectly impact sea turtles, by altering their normal distribution and attracting turtles to the heated discharge (potentially resulting in a cold stun event), or modifying the distribution and abundance of prey resources in the action area. The use of chlorine to control biofouling at the OCNGS may also affect turtles, albeit to an unknown extent, if chlorine is found in the discharge.

Over the next twenty years, an unknown number of loggerhead, Kemp's ridley, and green sea turtles may be injured or killed by commercial or recreational fisheries, vessel collisions, ingestion of debris, or chemical contamination in the action area. Adverse effects to sea turtle habitat are also expected to continue. Since quantitative data on the extent of these impacts to turtle populations are lacking, a reliable cumulative assessment of these effects is not possible.

Based on information provided in the Effects of the Action section of this Opinion, NMFS anticipates that no more than 5 loggerheads (no more than 2 lethal), 4 Kemp's ridleys (no more than 3 lethal), or 2 greens (no more than 1 lethal), will be taken each year as a result of the operation of the OCNGS. Based on the current status of the species, anticipated continuation of current levels of injury and mortality from other human activities described in the environmental baseline and cumulative effects section of this Opinion, and previous takes at the OCNGS, this level of take is not expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of the sea turtle populations considered in this opinion by reducing the numbers, distribution, or reproduction of the species.

CONCLUSION

After reviewing the current status of the species discussed herein, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, it is the NMFS' biological opinion that the proposed action may adversely affect but is not likely to jeopardize the continued existence of endangered Kemp's ridley, green, or threatened loggerhead sea turtles. No critical habitat has been designated in the action area, therefore, none will be affected.

INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by NMFS to include any act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns including breeding, spawning, rearing, migrating, feeding, or sheltering.

Harass is defined by FWS as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by NRC so that they become binding conditions for the exemption in section 7(o)(2) to apply. NRC has a continuing duty to regulate the activity covered by this Incidental Take Statement. If NRC (1) fails to assume and implement the terms and conditions or (2) fails to adhere to the terms and conditions of the Incidental Take Statement through enforceable terms, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, NRC must report the progress of the action and its impact on the species to the NMFS as specified in the Incidental Take Statement [50 CFR §402.14(i)(3)].

Amount or extent of take anticipated
NMFS anticipates that the continued operation of the OCNGS may result in the injury or mortality of loggerhead, Kemp's ridley, or green sea turtles. Based on previous levels of impingement, the distribution of sea turtle species, and the operation of the facility, NMFS anticipates that no more than five (5) loggerheads (no more than two (2) lethal), four (4) Kemp's ridleys (no more than three (3) lethal), or two (2) greens (no more than one (1) lethal), will be taken each year as a result of the operation of the OCNGS.

NMFS also expects that the OCNGS may take an additional unquantifiable number of previously dead loggerhead, Kemp's ridley and green sea turtles (turtles not killed as a result of plant operations) at the OCNGS intakes. The death of these turtles will not be considered related to plant operations and count towards the above referenced anticipated take level if: the dead or injured turtle is seen floating into the canal; the turtle can be determined to have been killed or injured by boat propellers and/or debris (such as discarded fishing equipment); if a turtle found on the intake trash bars from June 1 through October 31 (this is when daily inspections of the trash bars are done) is in an advanced state of decay; and any dead or injured turtle is found in the canal more than 30 meters away from the trash bars (NMFS assumes that it is unlikely that a turtle could be killed on the trash bars and then come loose and float against the flow and go into the main canal). All takes determined to be unrelated to OCNGS operations will be verified by the appropriate stranding/rehabilitation personnel.

Effect of the take
In the accompanying biological opinion, the NMFS determined that levels of anticipated take are not likely to result in jeopardy to loggerhead, Kemp's ridley, or green sea turtles.

Reasonable and Prudent Measures
The NMFS believes the following reasonable and prudent measures are necessary and appropriate to minimize impacts of incidental take of endangered and threatened sea turtles:

1. OCNGS must have a NMFS approved program in place to prevent, monitor, minimize, and mitigate the incidental take of sea turtles in the CWS and DWS intake structures.

2. All sea turtle impingements associated with the OCNGS and sea turtle sightings in the action area must be reported to NMFS.

Terms and Conditions
In order to be exempt from prohibitions of section 9 of the ESA, NRC must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

1. The Oyster Creek Nuclear Generating Station's CWS and DWS (when operational) intake trash bars must be cleaned daily from June 1 to October 31.

    a. Cleaning must include the full length of the trash rack, i.e., down to the bottom of each intake bay. To lessen the possibility of injury to a turtle, the raking process must be closely monitored so that it can be stopped immediately if a turtle is sighted.

    b. Personnel must be instructed to look beneath surface debris before the rake is used to lessen the possibility of injury to a turtle.

    c. Personnel cleaning the racks must inspect all trash that is dumped, particularly at night. Turtles or turtle parts might be confused with horseshoe crabs caught on the racks in abundance.

    d. An alternative method of daily cleaning of the trash racks must be developed for use between June 1 through October 31 when the trash rake is unavailable due to necessary repair or maintenance.

2. Inspection of CWS and DWS cooling water intake trash bars (and immediate area upstream) must continue to be conducted at least once every 4 hours (twice per 8-hour shift) from June 1 through October 31. Inspections must follow a set schedule so that they are regularly spaced rather than clumped. The proposed schedule of 1-2 hours into each 8-hour shift and 5-6 hours into each 8-hour shift must be followed. Times of inspections, including those when no turtles were sighted, must be recorded.

3. Lighting must be maintained at the intake bays to enable inspection personnel to see the surface of each intake bay and to facilitate safe handling of turtles which are discovered at night. Portable spotlights must be available at both the CWS and the DWS for times when extra lighting is needed.

4. Dip nets, baskets, and other equipment must be available at both the CWS and the DWS and must be used to remove smaller sea turtles from the OCNGS intake structures to reduce trauma caused by the existing cleaning mechanism. Each intake structure must have equipment suitable for rescuing large turtles as well (e.g., rescue sling or other provision).

5. If any live or dead sea turtles are taken at OCNGS, plant personnel must notify NMFS within 24 hours of the take (Carrie McDaniel at 978-281-9388 or Mary Colligan at 978-

281-9116). An incident report for sea turtle take (Appendix III) must also be completed by plant personnel and sent to Carrie McDaniel via FAX (978-281-9394) within 24 hours of the take. Every sea turtle incidental take must be photographed. Information in Appendix IV will assist in identification of species impinged. All sea turtles that are sighted within the vicinity of OCNGS (including the intake and discharge structures) must also be recorded, and this information must be submitted in the annual report.

6. An attempt to resuscitate comatose sea turtles must be made according to the procedures described in Appendix II. These procedures must be posted in appropriate areas such as the intake bay areas for both the CWS and the DWS, any other area where turtles would be moved for resuscitation, and the CWS and DWS operator's office(s).

7. All live sea turtles must be transported to a stranding/rehabilitation facility with the appropriate ESA authority by the stranding/rehabilitation personnel for evaluation, necessary veterinary care, tagging, and release in an appropriate location and habitat.

8. All dead sea turtles that are in adequate condition (i.e., relatively fresh dead) must be necropsied by qualified personnel. The OCNGS must coordinate with a qualified facility or individual to perform the necropsies on sea turtles impinged at OCNGS, prior to the incidental turtle take, so that there is no delay in performing the necropsy or obtaining the results. The necropsy results must identify, when possible, the sex of the turtle, stomach contents, and the estimated cause of death. Necropsy reports must be submitted to the NMFS Northeast Region with the annual review of incident reports or, if not yet available, within 1 year of the incidental take.

9. OCNGS personnel must also look for signs of sea turtles inside the canal and at a distance from the intake structures, where and when possible (i.e., during the daylight hours). Any sea turtles sighted in the canal and in vicinity of OCNGS (not necessarily only near the intake structures) must be reported to NMFS within 24 hours of the observation at (978) 281-9388 or FAX (978) 281-9394.

10. An annual report of incidental takes must be submitted to NMFS by January 1 of each year. This report will be used to identify trends and further conservation measures necessary to minimize incidental takes of sea turtles. The report must include, as detailed above, all necropsy reports, incidental take reports, photographs (if not previously submitted), all sightings in the vicinity of OCNGS, and a record of when inspections of the intake trash bars were conducted for the 24 hours prior to the take. The annual report must also include any potential measures to reduce sea turtle impingement or mortality at the intake structures.

11. The plant personnel or NRC must notify NMFS when the OCNGS reaches 50% of the incidental take level for any species of sea turtle. At that time, NRC and NMFS will determine if additional measures are needed to minimize impingement at the CWS or DWS intake structures.

NMFS anticipates that no more than 5 loggerheads (no more than 2 lethal), 4 Kemp's ridleys (no more than 3 lethal), or 2 greens (no more than 1 lethal), will be taken each year as a result of the operation of the OCNGS. The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the potential for and impact of incidental take that

might otherwise result from the proposed action. If, during the course of the action, the level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. When the incidental take has been reached/exceeded, the NRC must immediately provide an explanation of the causes of the taking and review with the NMFS the need for possible modification of the reasonable and prudent measures.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. NMFS has determined that the continued operation of the OCNGS as proposed is not likely to jeopardize the continued existence of endangered and threatened sea turtles located in the project area. To further reduce the adverse effects of the dredging project on listed species, NMFS recommends that NRC implement the following conservation measures.

1. In conjunction with NMFS, the NRC should support and develop a research program to determine whether the plant provides features attractive to sea turtles (e.g., concentration of prey around intake structures, heated discharge). This program should investigate habitat use, diet, and local and long-term movements. Use of existing mark/recapture and telemetry methods should be considered in Barnegat Bay and associated waterways.

2. The NRC and OCNGS personnel should support and conduct underwater videography or diving behavior telemetry studies of turtles at the intake bays, in the Forked River, in the Oyster Creek discharge canal, and in Barnegat Bay to determine how turtles use these waterways and their behavior in the intake bays.

3. The NRC and OCNGS personnel should support and conduct in-water assessments, abundance, and distribution surveys for sea turtles in Barnegat Bay, Forked River, and Oyster Creek. Information obtained from these surveys should include the number of turtles sighted, species, location, habitat use, time of year, and portions of the water column sampled.

4. Historical benthic survey data should be reviewed and updated to identify sea turtle prey density and distribution at various sites in the action area and associated waterways. This information would clarify the potential for sea turtle prey to be attracted to the intake structures or area around OCNGS during times when turtles are likely to be in the action area.

5. NRC should communicate with NMFS on an annual basis to review incidental takes of sea turtles at OCNGS, assess the status of sea turtles in the project area and associated waterways, and to reconsider the Reasonable and Prudent Measures and Terms and Conditions of this Opinion as appropriate.

REINITIATION OF CONSULTATION

This concludes formal consultation on the operation of the OCNGS. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of taking specified in the incidental take statement is exceeded; (2) 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; (3) the identified action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in this biological opinion; or (4) a new species is listed or critical habitat designated that may be affected by the identified action. In instances where the amount or extent of incidental take is exceeded, the NRC must immediately request initiation of formal section 7 consultation.

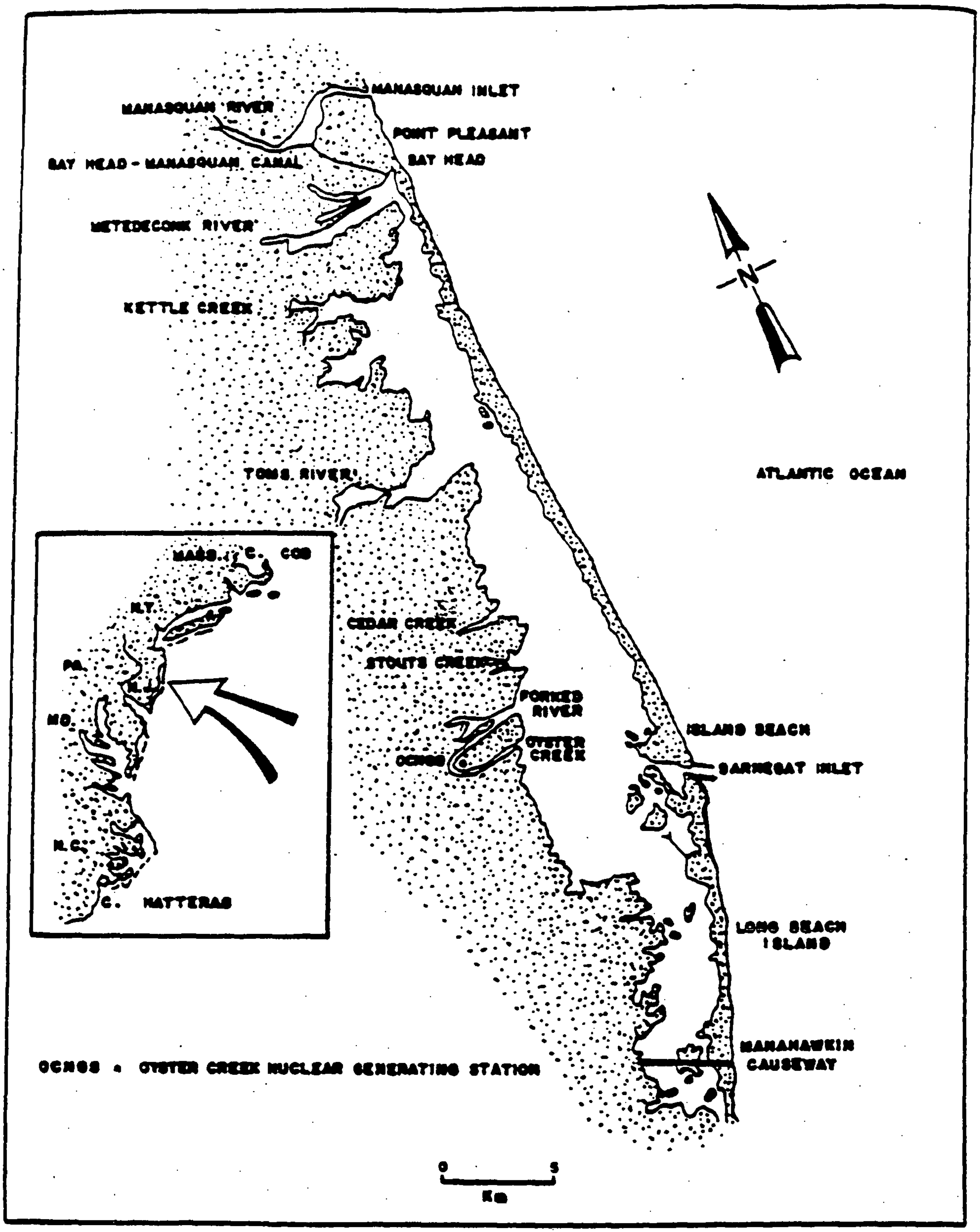


Figure 1. Map of Barnegat Bay, New Jersey and Oyster Creek NGS. Inset shows Barnegat Bay in relationship to the Mid-Atlantic Bight. (After Kennish and Lutz, 1984).

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APPENDIX I.

Incidental Take of Sea Turtles at Oyster Creek Nuclear Generating Station Intake Structures
January 1992 through December 2001

SEA TURTLE IMPINGEMENT							
Date/Time	*Species*	*Status*	*Length**	Weight	*Location*	*Temp*	*Details*
6/25/1992 1250 hrs	Cc	Dead	35.5 cm SCL	9.6 kg	found at DWS intake trash bars	21.6 C	Several deep gashes on side, appeared to be boat propeller wounds. MMSC necropsy concluded cause of death from propeller wounds, before impingement.
9/9/1992 1800 hrs	Cc	Alive	46.7 cm SCL	19.1 kg	found live upon routine inspection of CWS trash bars	25.6 C	Small wound with scar tissue behind head. Released into discharge canal.
9/11/1992 1400 hrs	Cc	Alive	46.7 cm SCL	19.1 kg	found live, impinged on CWS trash bars, upon routine inspection	26.2 C	Small wound with scar tissue behind head. Considered to be the same turtle found on 9/9/92. Taken to MMSC, tagged, and released into ocean near Brigantine, NJ.
10/26/1992 0300 hrs	Lk	Alive	32.0 cm SCL	5.7 kg	found live, impinged on CWS trash bars, upon routine inspection. Head out of water pointing upward.	11.3 C	Turtle found alive, moving about normally. Two scars from slash-like wounds on plastron. Not sure how long present at intake structure, but may have been there between 3 and 8 hours. Turtle taken to MMSC in Brigantine, NJ, then to North Carolina, with eventual release into the ocean off NC on October 31, 1992.
10/17/1993 1200 hrs	Lk	Dead	26.0 cm SCL	3.0 kg	found impinged against DWS trash bars upon routine inspection	16.7 C	Turtle found limp, immobile, no apparent breathing and resuscitation efforts were unsuccessful. Minor scrape marks on plastron may have occurred during removal from intake area. Not sure how long present at intake structure, but may have been there between 4 and 8 hours. Necropsy by Dr. Morreale found that drowning likely cause of death (fresh dead, no obvious trauma, empty stomach).
6/19/1994 1330 hrs	Cc	Alive	36.8 cm SCL	9.8 kg	found live while routinely inspecting CWS intake Bay #4, swimming freely upstream of the trash bars	27.3 C	Turtle found alive, moving about normally. Within 3-4 hours of capture, turtle taken to MMSC in Brigantine, NJ, tagged, and released offshore.
7/1/1994 1000 hrs	Lk	Dead	27.7 cm SCL	3.6 kg	found at Bay #5 of DWS upon routine cleaning of dilution intakes	25.7 C	Turtle found limp, immobile, no apparent breathing, strong odor of decomposition, and resuscitation efforts were unsuccessful. Not sure how long present at intake structure, but intake bay was cleaned the previous afternoon. Turtle sent to Cornell for necropsy but the results have not been received to date.

7/6/1994 0640 hrs	Cc	Dead	61.4 cm SCL	40.4 kg	found at Bay #4 of DWS upon routine cleaning of dilution intakes	26.9 C	Turtle found limp, immobile, no apparent breathing and resuscitation efforts were unsuccessful. Three old deep scars or slash-like propeller wounds on turtle, decomposition of all 4 appendages, large notch along turtle's marginal scutes. Not sure how long present at intake structure, but trash bars were cleaned 6 to 8 hours earlier. Necropsy by MMSC (R. Schoelkopf) found that turtle likely died 1 to 2 days before arriving at OCNGS, probably due to a long term illness.
7/12/1994 2240 hrs	Lk	Dead	26.7 cm SCL	3.3 kg	found at Bay #4 of DWS upon routine cleaning of dilution intakes	28.4 C	Turtle found limp, immobile, no apparent breathing and resuscitation efforts were unsuccessful. Not sure how long present at intake structure, but may have been there for several hours. Turtle sent to Cornell for necropsy but the results have not been received to date.
9/4/1997 0318 hrs	Lk	Dead	48.8 cm SCL	18.1 kg	found at Bay #6 of DWS upon routine cleaning of dilution intakes	22.9 C	Turtle found limp, immobile, no apparent breathing and resuscitation efforts were unsuccessful. Two dorsal scutes had damage, but no prominent scars of slashlike wounds. Not sure how long present at intake structure, but may have been there for up to several hours.
8/18/1998 0959 hrs	Cc	Alive	50.8 cm SCL	22.4 kg	found live while routinely inspecting CWS intake Bay #4, swimming freely upstream of the trash bars	26.9 C	Turtle found alive, moving about normally. A 12 foot 1/4" polypropylene rope with a bucket attached to one end was wrapped around the right front flipper, and the flipper was atrophied and partially decayed. OCNGS was in full power operation with four circulating water pumps and 2 dilution pumps. Turtle taken to MMSC in Brigantine, NJ, then to Sea World in Orlando, FL, with eventual release into the ocean.
9/23/1999 0310 hrs	Lk	Alive	26.4 cm SCL	2.9 kg	found live while routinely inspecting CWS intake, impinged against trash bars	19.6 C	Turtle found alive, moving about normally and with no apparent injury. OCNGS was in full power operation with four circulating water pumps and 2 dilution pumps. Turtle taken to MMSC in Brigantine, NJ, then to Virginia State Aquarium, with eventual release into the ocean.
10/23/1999 0200 hrs	Cm	Dead	27.0 cm SCL	2.8 kg	found in the trash bars in Bay #4 of DWS on routine inspection of dilution intake	17.1 C	Turtle found limp, immobile, no apparent breathing and resuscitation efforts were unsuccessful. OCNGS was in full power operation with four circulating water pumps and 2 dilution pumps. Dilution trash racks were mechanically cleaned the previous day. Turtle sent to Cornell for necropsy, but results have not been received to date.
06/23/2000 0120 hrs	Cc	Alive	47.8cm SCL	17.2 kg	removed from in front of trash bars in Bay #1 of DWS intake	25.3 C	Live turtle very active and no visible wounds or injury. OCNGS was in full power operation with four circulating water pumps and 2 dilution pumps. Transferred to MMSC in Brigantine NJ, with eventual release into the ocean.

7/2/2000 1500 hrs	Lk	Dead	27.3 cm SCL	3.2 kg	found floating into the trash bars in Bay #1 of DWS intake on routine inspection of dilution trash racks	25.6 C	Turtle found limp, immobile, no apparent breathing and resuscitation efforts were unsuccessful. Two dorsal scutes had superficial scrape marks. OCNGS was in full power operation with four circulating water pumps and 2 dilution pumps. Dilution trash racks were mechanically cleaned the previous evening (2130 hrs). Turtle in freezer until necropsy can be completed.
8/3/2000 1525 hrs	Cm	Alive	29.2 cm SCL	3.4 kg	found live in Bay #4 of DWS intake upon routine inspection of dilution trash racks	28.8 C	Turtle found alive, moving about normally and with no apparent injury. Carapace covered in barnacles; several marginal scutes had dull grayish coloration (indicative of possible fungal infection). OCNGS was in full power operation with four circulating water pumps and 2 dilution pumps. Dilution trash racks mechanically cleaned earlier the same day. Turtle taken to MMSC in Brigantine, NJ, then to the Topsail Island Rehab Center, NC, with eventual release into the ocean on October 12, 2000.
8/28/2000 0112 hrs	Lk	Alive	26.2 cm SCL	2.9 kg	found live in Bay #1 of DWS intake upon routine inspection of dilution trash racks	26.5 C	Turtle found alive, moving about normally and with no apparent injury. OCNGS was in 72% power operation with four circulating water pumps and 2 dilution pumps. Dilution trash racks cleaned previous day and inspected earlier same night of capture. Turtle taken to MMSC in Brigantine, NJ, then to the Topsail Island Rehab Center, NC, with anticipated eventual release into the ocean.
9/18/2000 1310 hrs	Cc	Alive	57.2 cm SCL	26.5 kg	found live while routinely inspecting CWS intake trash rack Bay #4	20.4 C	Turtle found alive, moving normally with no apparent injury. Majority of dorsal surface covered in barnacles; few scutes partially peeled. OCNGS was in full power operation with four circulating water pumps and 2 dilution pumps. Trash racks cleaned previous afternoon. Turtle taken to MMSC in Brigantine, NJ, and released into the ocean off Nags Head, NC in late September.

*SCL=straight carapace length

APPENDIX II, continued **(Handling and Resuscitation Procedures)**

Stranding/rehabilitation contact in New Jersey:

- Bob Schoelkopf, Marine Mammal Stranding Center, P.O. Box 773, Brigantine, NJ (609-266-0538).

Special Instructions for Cold-Stunned Turtles:
Comatose turtles found in the fall or winter (in waters less than 10°C) may be "cold-stunned". If a turtle appears to be cold-stunned, the following procedures should be conducted:

- Contact the designated stranding/rehabilitation personnel immediately and arrange for them to pick up the animal.

- Until the rehabilitation facility can respond, keep the turtle in a sheltered place, where the ambient temperature is cool and will not cause a rapid increase in core body temperature.

APPENDIX III

Incident Report of Sea Turtle Take - OCNGS

Photographs should be taken and the following information should be collected from all turtles (alive and dead) found in association with the OCNGS. Please submit all necropsy results (including sex and stomach contents) to NMFS upon receipt.

Observer's full name:____________________

Reporter's full name:____________________

Species Identification (Key attached):____________________

Site of Impingement (CWS or DWS, Bay #, etc.):____________________

Date animal observed:__________ Time animal observed: __________

Date animal collected:__________ Time animal collected:__________

Date rehab facility contacted: __________ Time rehab facility contacted: __________

Date animal picked up: __________ Time animal picked up: __________

Environmental conditions at time of observation (i.e., tidal stage, weather): __________

____

Date and time of last inspection of screen:____________________

Water temperature (°C) at site and time of impingement:____________________

Intake velocity at site and time of impingement (ft/sec):____________________

Average percent of power generating capacity achieved per unit over the 48 hours previous to impingement: ____________________

Sea Turtle Information: *(please designate cm/m or inches)*

Fate of animal (circle one): dead alive

Condition of animal (*include comments on injuries, whether the turtle is healthy or emaciated, general behavior while at OCNGS*):____________________

____

____

____________________*(please complete attached diagram)*

Carapace length - Curved:__________Straight:__________

Carapace width - Curved:__________Straight:__________

Existing tags?: YES / NO *Please record all tag numbers.* Tag # __________

Photograph attached: YES / NO

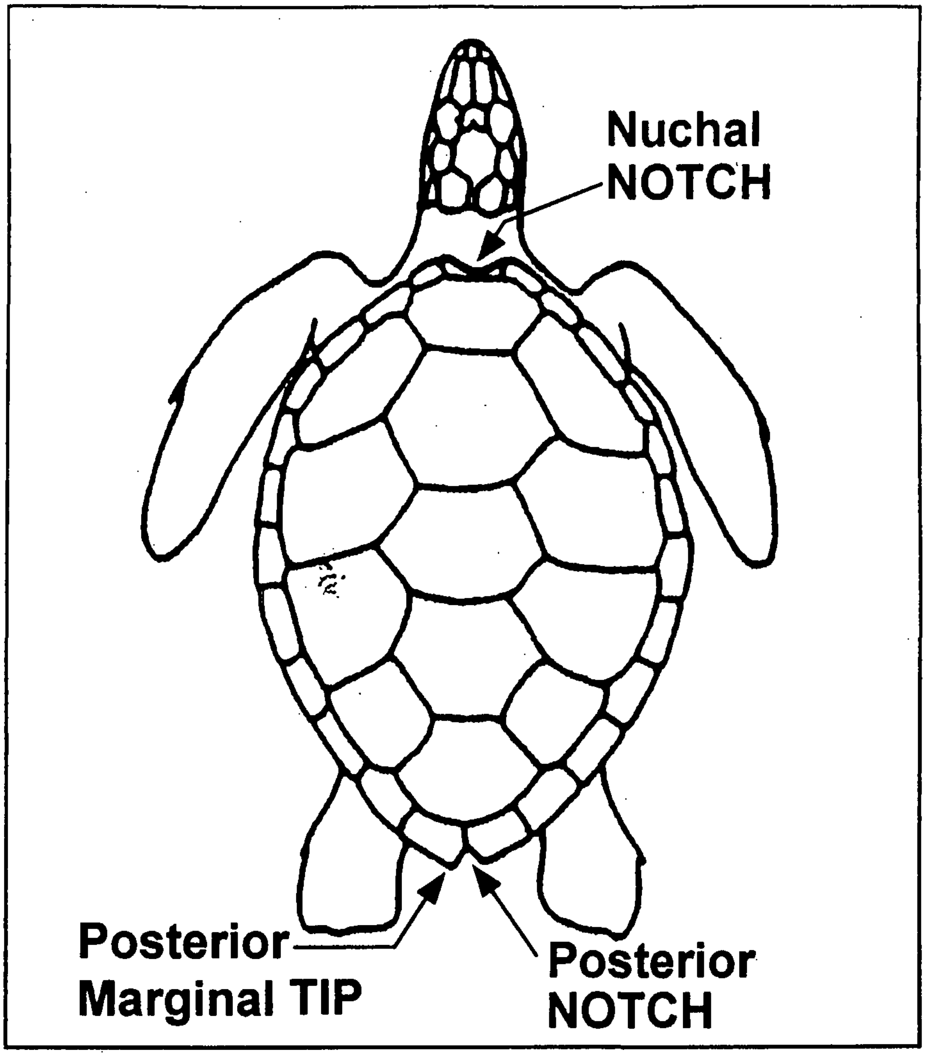
(please label *species, date, location of impingement* on back of photograph)

All information should be sent to the following address:

National Marine Fisheries Service Northeast Region
Protected Resources Division
One Blackburn Drive
Gloucester, MA 01930
Attention: Carrie McDaniel

APPENDIX III, continued (**Incident Report of Sea Turtle Take)**

Draw wounds, abnormalities, tag locations on diagram and briefly describe below.

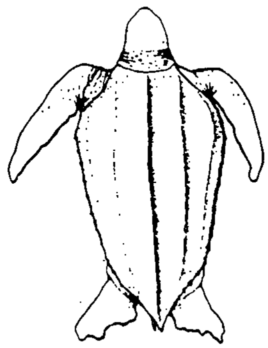


Description of animal:

APPENDIX IV
Identification Key for Sea Turtles Found in Northeast U.S. Waters

SEA TURTLES

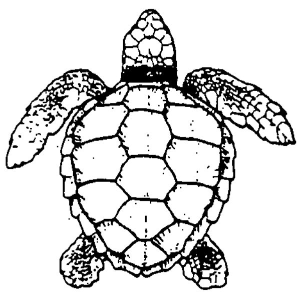
Dc



Leatherback (*Dermocheyls coriacea*)

Found in open water throughout the Northeast from spring through fall. Leathery shell with 5-7 ridges along the back. Largest sea turtle (4-6 feet). Dark green to black; may have white spots on flippers and underside.

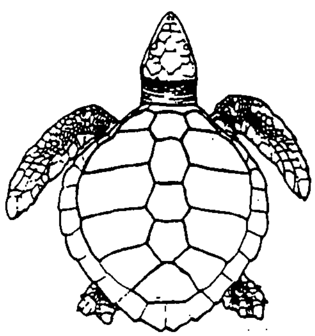
Cc



Loggerhead (*Caretta caretta*)

Bony shell, reddish-brown in color. Mid-sized sea turtle (2-4 feet). Commonly seen from Cape Cod to Hatteras from spring through fall, especially in southern portion of range. Head large in relation to body.

Lk



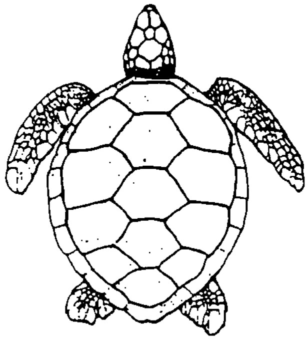
Kemp's ridley (*Lepidochelys kempi*)

Most often found in Bays and coastal waters from Cape Cod to Hatteras from summer through fall. Offshore occurrence undetermined. Bony shell, olive green to grey in color. Smallest sea turtle in Northeast (9-24 inches). Width equal to or greater than length.

APPENDIX IV, continued (**Identification Key**)

SEA TURTLES

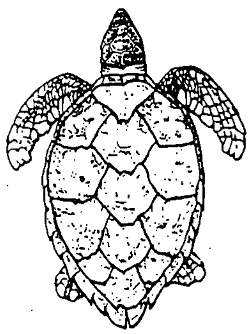
Cm



Green turtle (*Chelonia mydas*)

Uncommon in the Northeast. Occur in Bays and coastal waters from Cape Cod to Hatteras in summer. Bony shell, variably colored; usually dark brown with lighter stripes and spots. Small to mid-sized sea turtle (1-3 feet). Head small in comparison to body size.

Ei



Hawksbill (*Eretmochelys imbricata*)

Rarely seen in Northeast. Elongate bony shell with overlapping scales. Color variable, usually dark brown with yellow streaks and spots (tortoise-shell). Small to mid-sized sea turtle (1-3 feet). Head relatively small, neck long.

ENDANGERED SPECIES ACT SECTION 7 CONSULTATION

BIOLOGICAL OPINION

Agency: Nuclear Regulatory Commission

Activity: Reinitiation of Consultation for the Continued Operation of the Oyster Creek Nuclear Generating Station on the Forked River and Oyster Creek, Barnegat Bay, New Jersey

Conducted by: NOAA's National Marine Fisheries Service, Northeast Regional Office

Date Issued: Sept 22, 2005

Approved by: [signature]

INTRODUCTION

This constitutes NOAA's National Marine Fisheries Service's (NMFS) biological opinion (Opinion) on the effects of the Nuclear Regulatory Commission's (NRC) continued operation of the Oyster Creek Nuclear Generating Station (OCNGS) on threatened and endangered species in accordance with section 7 of the Endangered Species Act of 1973, as amended. Consultation was reinitiated due to the exceedence of the Incidental Take Statement issued to the facility on July 18, 2001.

This Opinion is based on information provided in the March 29, 2005 Biological Assessment (BA), correspondence with Ms. Harriet Nash, NRC, Mr. Mike Masnik, NRC, and Mr. Malcolm Browne, AmerGen Energy Company, and other sources of information. A complete administrative record of this consultation will be kept on file at the NMFS Northeast Regional Office, Gloucester, Massachusetts.

CONSULTATION HISTORY

The OCNGS began commercial operation in 1969. No observed takes of endangered or threatened species occurred at the OCNGS prior to 1992. However, between June 1992 and July 1994, 9 sea turtle impingements occurred at the OCNGS intake trash bars, including 5 loggerheads (4 individuals, 1 recapture), and 4 Kemp's ridleys. In a letter dated November 2, 1993, NMFS stated that formal consultation on the operation of the OCNGS was necessary due to takes of threatened and endangered sea turtles. In a letter dated November 19, 1993, the NRC requested formal consultation. A BA was prepared by the OCNGS, reviewed and submitted by the NRC, and received by NMFS on January 25, 1995.

A Biological Opinion on the effects of the operation of OCNGS on loggerhead, green, and Kemp's ridley sea turtles was signed on September 21, 1995. This Opinion concluded that the continued operation of this station may adversely affect listed turtles, but is not likely to jeopardize their continued existence. The accompanying Incidental Take Statement exempted the annual take of 10 loggerhead (no more than 3 lethal), 3 Kemp's ridley (no more than 1 lethal), and 2 green (no more than 1 lethal) sea turtles. The incidental take exemption extended for a period of 5 years from the date of the Opinion (i.e., to September 21, 2000).

After the 1995 Opinion was signed, there were nine takes of sea turtles associated with the OCNGS. The specifics of these takes are discussed in the following Effects of the Action section. The 1995 incidental take level was met during three of these years: in 1997 with the lethal take of a Kemp's ridley turtle, in 1999 with the lethal take of a green turtle, and again in 2000 with the lethal take of a Kemp's ridley turtle. However, these takes did not trigger reinitiation of formal consultation on OCNGS. Section 7 consultation must be reinitiated if "the amount or extent of taking specified in the incidental take statement is exceeded" 50 CFR 402.16. In the cover letter accompanying the 1995 BO, NMFS stated that reinitiation would be required if, during any one year, twelve sea turtles are taken and/or there is a lethal take of one Kemp's ridley or one green turtle. However, as noted above, reinitiation is not actually required unless the Incidental Take Statement is exceeded. The Incidental Take Statement in the 1995 Opinion exempted the annual lethal take of one Kemp's ridley and one green turtle, and this level of taking had not been exceeded.

On August 3, 2000, NMFS was copied on a letter from the Acting Site Director of the OCNGS, Sander Levin, to the NRC, requesting the renewal of the Biological Opinion/Incidental Take Statement and submitting an updated BA. In a telephone conversation on August 24, 2000, NRC informed NMFS that shortly they would be sending a letter requesting reinitiation of formal consultation. On September 18, 2000, four days before the previous incidental take statement was to expire, NRC requested reinitiation of formal consultation on the effects of the OCNGS on sea turtles and submitted a revised BA. In a letter dated October 6, 2000, NMFS acknowledged the receipt of the formal consultation request and the BA. At that time, NMFS requested additional information, including updated sea turtle take details, necropsy results, and updated New Jersey stranding records, before formal consultation could proceed.

During a telephone discussion in December 2000, NRC and AmerGen staff informed NMFS that information was not available for several items requested in NMFS' October 6 letter (e.g., updated necropsy information). On January 23, 2001, the NRC submitted supplemental information and clarification on the BA as requested by NMFS. NRC also identified areas where data were lacking or unavailable. Consultation was completed with the issuance of an Opinion dated July 18, 2001. The accompanying Incidental Take Statement exempted the annual take of 5 loggerheads (no more than 3 lethal), 4 Kemp's ridley (no more than 3 lethal), and 2 green (no more than 1 lethal) sea turtles. A revised Incidental Take Statement was issued on August 29, 2001 in response to concerns raised by the AmerGen Energy Company in regards to some requirements in the terms and conditions; however, no changes were made to the numbers of exempted sea turtle takes.

On August 7, 2004, the OCNGS recorded its fifth incidental take of a Kemp's ridley sea turtle since the beginning of the year, thus exceeding the incidental take statement for the facility. This incidental take was followed by 3 more takes of Kemp's ridley sea turtles on September 11, September 12, and September 23, 2004 respectively. The amount of taking exempted by the incidental take statement was exceeded, and in a letter dated August 26, 2004 NRC requested reinitiation of formal section 7 consultation under the Endangered Species Act (ESA) for the OCNGS. On April 28, 2005 NMFS received a BA, dated March 29, 2005 from the NRC.

On June 3, 2005 NMFS informed NRC that all the information necessary for a formal section 7 consultation and the preparation of a Biological Opinion had been received and reminded NRC not to make any irreversible or irretrievable commitments of resources that would prevent NMFS from proposing or the NRC from implementing any reasonable and prudent alternatives to avoid jeopardizing sea turtles. Also in this letter, NMFS recommended that the NRC continue to implement the requirements identified in the July 18, 2001 Opinion until consultation is concluded.

DESCRIPTION OF THE PROPOSED ACTION

The proposed activity is the continued operation of the Oyster Creek Nuclear Generating Station. OCNGS is located near the Town of Forked River, midway between the south branch of the Forked River and Oyster Creek, New Jersey, under a license issued by the NRC on April 9, 1989, which is set to expire on April 9, 2009. The Forked River and Oyster Creek empty into Barnegat Bay. When the plant is operational, the flow direction in the south fork of the Forked River is reversed, and all of the flow goes into the OCNGS. The resultant warmed water is discharged via Oyster Creek into Barnegat Bay.

OCNGS consists of a boiling water nuclear reactor with an electrical capability of approximately 650 megawatts. Two separate intake structures withdraw water from the intake canal, the circulating water system intake (CWS) and the dilution water system (DWS).

The CWS provides cooling water for the main condensers and for safety-related heat exchangers and other equipment within the station. Water is drawn into the CWS from the intake canal (south fork of the Forked River) through six intake bays and is subsequently discharged into the discharge canal as heated effluent. During normal plant operation, four circulating water pumps withdraw a total of 1740 m^3/min of water, and the maximum permissible average intake velocity for water approaching the CWS intake ports is 30 cm/sec. The maximum effluent temperature is 41.1^{0}C.

The DWS minimizes the thermal effects on the discharge canal and Barnegat Bay by thermally diluting the circulating water from the condenser with colder ambient temperature water. Water is pumped from the intake canal through the six intake bays and discharged directly into the discharge canal, where it mixes with and reduces the temperature of the heated effluent from the CWS. A maximum of two dilution pumps are operated at one time, but when water temperature exceeds 30.5 C, usually only one dilution pump is put into operation. The average intake velocity for water in front of the DWS intake (with two pumps in operation) is approximately 73

cm/sec. As expected, the average intake velocity with one DWS pump in operation is notably less than 73 cm/sec.

The dimensions and structures at the CWS are nearly identical to those of the DWS. Several differences are that the intake velocity at the DWS is much higher than at the CWS, and the CWS has a vertical traveling screen to filter small organisms. The intakes at both the CWS and DWS are screened by six sets of trash bars, which extend from the bottom of each intake bay to several feet above the water (7.3 m high and 3.3 m wide). The depth at the intake bays are approximately 4 to 6 meters deep. The trash bars are 0.95 cm wide steel bars set on 7.5 cm centers, and the openings between the trash bars are 6.6 cm wide. A trash rake assembly traverses the entire width of the intake on rails; it contains a trash hopper which transports the material removed from the bars to a debris container. Personnel cleaning the CWS and DWS intake trash racks from June to October observe the trash rake during the cleaning operation so that the rake may be stopped if a sea turtle is sighted. The trash bars are inspected at least twice during each 8-hour work shift from June to October to remove debris and to monitor potential sea turtle takes.

A floating debris/ice barrier has been designed and installed upstream of the CWS and DWS intake structures to divert floating debris (e.g., wood, eelgrass, ice) away from the CWS intake and towards the DWS intake. The barrier is intended to prevent excessive amounts of debris or ice from accumulating on the CWS traveling screen or trash bars. The wood floating barrier extends 60 cm below the surface, so that if a turtle is near the surface when approaching the floating barrier, it may be diverted towards the DWS unless it dives deeper and turns towards the CWS.

Both intakes have sea turtle retrieval/rescue equipment on site in the event of a sea turtle impingement. At the CWS intake structure, a rescue sling suitable for lifting large sea turtles (in excess of 20 kg) is present. Long-handled dip nets are present at the CWS and DWS intake structures during June through October, and are suitable for retrieving the smaller turtles which are more likely to be found at the OCNGS. Both the rescue sling and the long-handled dip nets are only adequate for retrieving turtles from the water surface or within about 1 meter of the surface, as the use of either device requires that the sea turtle be visible from the surface.

Action Area

The action area is defined in 50 CFR 402.02 as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." The direct and indirect effect of the OCNGS are the intake of water into the CWS and DWS from the south fork of the Forked River, which causes a reversal of normal flow, and the discharge of warmed and chlorinated water into Oyster Creek and Barnegat Bay. The discharge plume occupies Oyster Creek and extends into a relatively large surface area of Barnegat Bay (estimated to be less than 1.6 km in an east-west direction by 5.6 km in a north-south direction, under all conditions). In general, elevated temperatures do not extend to the bottom of the Bay except in the area immediately adjacent to the mouth of Oyster Creek.

Therefore, the action area for this consultation includes the intake areas of both the DWS and CWS intakes at the OCNGS, the south fork of Forked River, Oyster Creek, and the region where the thermal plume extends into Barnegat Bay from Oyster Creek.

STATUS OF SPECIES AND CRITICAL HABITAT

No critical habitat has been designated for any species under NMFS' jurisdiction in the action area, therefore, no critical habitat will be affected by the proposed action.

Species Not Likely to Occur in the Action Area

NMFS has determined that the action being considered in this Opinion is not likely to adversely affect leatherback (*Dermochelys coriacea*) or hawksbill (*Eretmochelys imbricata*) sea turtles, which are listed as endangered under the ESA.

<u>Leatherback sea turtle</u>

Leatherbacks are widely distributed throughout the oceans of the world, and are found in waters of the Atlantic, Pacific, Caribbean, and the Gulf of Mexico (Ernst and Barbour 1972). In the U.S. Atlantic Ocean, leatherback turtles are found in northeastern waters during the warmer months. This species is found in coastal waters of the continental shelf and near the Gulf Stream edge (Lutcavage 1996). Leatherbacks are predominantly a pelagic species and feed on jellyfish, cnidarians and tunicates, they will travel to nearshore areas when in pursuit of these prey species.

Estimated to number approximately 115,000 adult females globally in 1980 (Pritchard 1982) and only 34,500 by 1995 (Spotila *et al.* 1996), leatherback populations have been decimated worldwide, not only by fishery related mortality but, at least historically, primarily due to intense exploitation of the eggs (Ross 1979). The status of the leatherback population in the Atlantic is difficult to assess since major nesting beaches occur over broad areas within tropical waters outside the United States. Recent information suggests that Western Atlantic populations declined from 18,800 nesting females in 1996 (Spotila et al., 1996) to 15,000 nesting females by 2000 (Spotila, pers. comm).

Leatherbacks have been documented in waters off New Jersey and have also been found stranded on New Jersey coastal and estuarine beaches. Shoop and Kenney (1992) observed concentrations of leatherbacks during the summer off the south shore of Long Island and off New Jersey. Leatherbacks in these waters are thought to be following their preferred jellyfish prey. This aerial survey estimated the leatherback population for the northeastern U.S. at approximately 300-600 animals (from near Nova Scotia, Canada to Cape Hatteras, North Carolina).

The only direct access to Barnegat Bay from the Atlantic Ocean is through a single, narrow inlet, approximately 300 m wide. While leatherbacks could enter Barnegat Bay, it is improbable given that this species is rarely found in inshore waters. Furthermore, given this species' distribution and migratory and foraging patterns, it is also unlikely that this species will travel through the navigation channels to reach the OCNGS. As a result, it is not likely that the action being considered in this Opinion will adversely affect leatherback sea turtles.

Hawksbill sea turtle

The hawksbill turtle is relatively uncommon in the waters of the continental United States. Hawksbills prefer coral reefs, such as those found in the Caribbean and Central America. Hawksbills feed primarily on a wide variety of sponges but also consume bryozoans, coelenterates, and mollusks. The Culebra Archipelago of Puerto Rico contains especially important foraging habitat for hawksbills. Nesting areas in the western North Atlantic include Puerto Rico and the Virgin Islands.

There are accounts of hawksbills in south Florida and a number are encountered in Texas. Most of the Texas records report small turtles, probably in the 1-2 year class range. Many of the captures or strandings that are reported are of individuals in an unhealthy or injured condition. The lack of sponge-covered reefs and the cold winters in the northern Gulf of Mexico probably prevent hawksbills from establishing a viable population in this area. In the north Atlantic, small hawksbills have stranded as far north as Cape Cod, Massachusetts. However, many of these strandings were observed after hurricanes or offshore storms. No takes of hawksbill sea turtles have been recorded in Northeast or mid-Atlantic fisheries covered by the Northeast Fisheries Science Center (NEFSC) observer program, but it should be noted that coverage has been limited in the past.

While hawksbills have occasionally been found in northern mid-Atlantic waters, it is improbable that this species will be present in the action area given its distribution, and migratory and foraging patterns. Thus, it is not likely that the action being considered in this Opinion will adversely affect hawksbill sea turtles.

Species Likely To Occur in the Action Area

The following endangered or threatened species under NMFS' jurisdiction are likely to occur in the action area.

Threatened:

Loggerhead sea turtle (*Caretta caretta*)

Endangered:

Green sea turtle[1] (*Chelonia mydas*)

Kemp's ridley sea turtle (*Lepidochelys kempi*)

Loggerhead sea turtle

Loggerhead sea turtles occur throughout the temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans in a wide range of habitats. These include open ocean, continental shelves, bays, lagoons, and estuaries (NMFS and USFWS, 1995). It is the most abundant species

[1]Green turtles in U.S. waters are listed as threatened except for the Florida breeding population which is listed as endangered. Due to the inability to distinguish between these populations away from the nesting beach, green turtles are considered endangered wherever they occur in U.S. waters.

of sea turtle in U.S. waters, commonly occurring throughout the inner continental shelf from Florida through Cape Cod, Massachusetts. NMFS Northeast Fisheries Science Center survey data (1999) has found that loggerheads may occur as far north as Nova Scotia when oceanographic and prey conditions are favorable. The loggerhead sea turtle was listed rangewide as threatened under the ESA on July 28, 1978, but is considered endangered by the World Conservation Union (IUCN).

Loggerhead sea turtles are generally grouped by their nesting locations. Nesting is concentrated in the north and south temperate zones and subtropics. Loggerheads generally avoid nesting in tropical areas of Central America, northern South America, and the Old World (National Research Council 1990). The largest known nesting aggregations of loggerhead sea turtles occurs on Masirah and Kuria Muria Islands in Oman (Ross and Barwani 1982). However, the status of the Oman nesting beaches has not been evaluated recently, and their location in a part of the world that is vulnerable to extremely disruptive events (e.g. political upheavals, wars, and catastrophic oil spills) is cause for considerable concern (Meylan et al. 1995).

In the Pacific Ocean, major loggerhead nesting grounds are generally located in temperate and subtropical regions with scattered nesting in the tropics. The abundance of loggerhead turtles on nesting colonies throughout the Pacific basin have declined dramatically over the past 10-20 years. Loggerhead sea turtles in the Pacific are represented by a northwestern Pacific nesting aggregation (located in Japan) and a smaller southwestern nesting aggregation that occurs in Australia (Great Barrier Reef and Queensland), New Caledonia, New Zealand, Indonesia, and Papua New Guinea. Data from 1995 estimated the Japanese nesting aggregation at 1,000 female loggerhead turtles (Bolten *et al.* 1996). More recent estimates are unavailable; however, qualitative reports infer that the Japanese nesting aggregation has declined since 1995 and continues to decline (Tillman 2000). In addition, genetic analyses of female loggerheads nesting in Japan indicates the presence of genetically distinct nesting colonies (Hatase *et al.* 2002). As a result, Hatase *et al.* (2002) suggest that the loss of one of these colonies would decrease the genetic diversity of loggerheads that nest in Japan, and recolonization of the site would not be expected on an ecological time scale. In Australia, long-term census data has been collected at some rookeries since the late 1960's and early 1970's, and nearly all the data show marked declines in nesting populations since the mid-1980's (Limpus and Limpus 2003). The nesting aggregation in Queensland, Australia, was as low as 300 females in 1997.

In the western Atlantic, most loggerhead sea turtles nest from North Carolina to Florida and along the gulf coast of Florida. In 1996, the Turtle Expert Working Group (TEWG) met on several occasions and produced a report assessing the status of the loggerhead sea turtle population in the western North Atlantic. The southeastern U.S. nesting aggregation is the second largest and represents about 35 percent of the nests of this species. From a global perspective, this U.S. nesting aggregations is, therefore, critical to the survival of this species. Based on analysis of mitochondrial DNA, which the turtle inherits from its mother, the TEWG theorized that nesting assemblages represent distinct genetic entities, and that there are at least four loggerhead subpopulations in the western North Atlantic separated at the nesting beach (TEWG 1998, 2000). A fifth subpopulation was identified in NMFS SEFSC 2001. The

subpopulations are divided geographically as follows: (1) a northern nesting subpopulation, occurring from North Carolina to northeast Florida, about 29° N (approximately 7,500 nests in 1998); (2) a south Florida nesting subpopulation, occurring from 29° N on the east coast to Sarasota on the west coast (approximately 83,400 nests in 1998); (3) a Florida panhandle nesting subpopulation, occurring at Eglin Air Force Base and the beaches near Panama City, Florida (approximately 1,200 nests in 1998); (4) a Yucatán nesting subpopulation, occurring on the eastern Yucatán Peninsula, Mexico (Márquez 1990; approximately 1,000 nests in 1998); and (5) a Dry Tortugas nesting subpopulation, occurring in the islands of the Dry Tortugas, near Key West, Florida (approximately 200 nests per year). Natal homing to the nesting beach is believed to provide the genetic barrier between these nesting aggregations, preventing recolonization from turtles from other nesting beaches. In addition, recent fine-scale analysis of mtDNA work from Florida rookeries indicate that population separations begin to appear between nesting beaches separated by more than 50-100 km of coastline that does not host nesting (Francisco et al. 1999) and tagging studies are consistent with this result (Richardson 1982, Ehrhart 1979, LeBuff 1990, CMTTP: in NMFS SEFSC 2001). Nest site relocations greater than 100 km occur, but are rare (Ehrhart 1979; LeBuff 1974, 1990; CMTTP; Bjorndal et at. 1983: in NMFS SEFSC 2001).

Mating takes place in late March through early June, and eggs are laid throughout the summer, with a mean clutch size of 100-126 eggs in the southeastern United States. Individual females will nest multiple times during a given nesting season, with a mean of 4.1 nests/individual (Murphy and Hopkins 1984). Nesting migrations for an individual female loggerhead are usually on an interval of 2-3 years, but can vary from 1-7 years (Dodd 1988).

A number of stock assessments (TEWG 1998; TEWG 2000; NMFS SEFSC 2001; Heppell *et al.* 2003) have examined the stock status of loggerheads in the waters of the United States, but have been unable to develop any reliable estimates of absolute population size. Due to the difficulty of conducting comprehensive population surveys away from nesting beaches, nesting beach survey data is used as an index to the status and trends of loggerheads (USFWS and NMFS 2003). Detection of nesting trends requires consistent data collection methods over long periods of time (USFWS and NMFS 2003). In 1989, a statewide sea turtle Index Nesting Beach Survey (INBS) program was developed and implemented in Florida, and similar standardized daily survey programs have been implemented in Georgia, South Carolina, and North Carolina (USFWS and NMFS 2003). Although not part of the INBS program, nesting survey data is also available for the Yucatán Peninsula, Mexico (USFWS and NMFS 2003). Between 1989 and 1998, the total number of nests laid along the U.S. Atlantic and Gulf coasts ranged from 53,014 to 92,182, annually with a mean of 73,751 (TEWG 2000).

As described above, nesting data collected over multiple years is necessary to help determine subpopulation trends given the yearly variability in nest counts. The source of this variability is unknown. It is likely that there are multiple causes including the cyclical nature of loggerhead nesting as well as sometimes devastating natural events such as hurricanes that have, for example, destroyed many nests in 2004.

The south Florida nesting group is the largest known loggerhead nesting assemblage in the Atlantic and one of only two loggerhead nesting assemblages worldwide that have greater than 10,000 females nesting per year (USFWS and NMFS 2003; USFWS Fact Sheet). Annual nesting totals have ranged from 48,531 - 83,442 annually over the past decade (USFWS and NMFS 2003). South Florida nests make up the majority (90.7%) of all loggerhead nests counted along the U.S. Atlantic and Gulf coasts during the period 1989-1998. The Turtle Expert Working Group's (TEWG 2000) assessment of the status of the south Florida subpopulation concluded that the south Florida subpopulation was increasing based on nesting data over the last couple of decades. However, more recent analysis of nesting data from the INBS program since 1989, including nesting data through 2003, indicate that there is no discernable trend for the south Florida subpopulation (Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute, Statewide and Index Nesting Beach Survey Programs; USFWS and NMFS 2003). The northern subpopulation is the second largest loggerhead nesting assemblage within the United States but much smaller than the south Florida nesting group. Of the total number of nests counted along the U.S. Atlantic and Gulf coasts during the period 1989-1998, 8.5% were attributed to the northern subpopulation. The number of nests for this subpopulation have ranged from 4,370 - 7,887 for the period 1989-1998, for an average of approximately 1,524 nesting females per year (USWFS and NMFS 2003). Based on this nesting data, the TEWG (2000) characterized this subpopulation as stable or declining. However, once again, more recent data suggest that there is no detectable trend for this subpopulation (Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute, Statewide and Index Nesting Beach Survey Programs). The remaining three subpopulations (the Dry Tortugas, Florida Panhandle, and Yucatán) are much smaller subpopulations but no less relevant to the continued existence of the species. Annual nesting totals for the Florida Panhandle subpopulation ranged from 113-1,285 nests for the period 1989-2002 (USFWS and NMFS 2003). Currently, there is not enough information to detect a trend for the subpopulation (Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute, Index Nesting Beach Survey Database). The Yucatán nesting group was reported to have had 1,052 nests in 1998 (TEWG 2000). Although Zurita *et al.* (2003) did find significant increases in loggerhead nesting on seven beaches at Quintana Roo, Mexico, nesting survey effort overall has been inconsistent among the Yucatán nesting beaches and no trend can be determined for this subpopulation. Nesting surveys for the Dry Tortugas subpopulation are conducted as part of Florida's statewide survey program. Survey effort has been relatively stable during the 9-year period from 1995-2003 (although the 2002 year was missed). Nest counts ranged from 168-270 but with no detectable trend during this period (Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute, Statewide Nesting Beach Survey Data).

Past literature gave an estimated age at maturity for loggerhead sea turtles of 21-35 years (Frazer and Ehrhart 1985; Frazer *et al.* 1994) with the benthic immature stage lasting at least 10-25 years. New data from tag returns, strandings, and nesting surveys suggested estimated ages of maturity ranging from 20-38 years and the benthic immature stage lasting from 14-32 years (NMFS SEFSC 2001). Caution must still be exercised, however, when defining the benthic immature stage. Like other sea turtles, loggerhead hatchlings enter the pelagic environment upon leaving the nesting beach. It had previously been thought that after approximately 7-12

years in the pelagic environment, immature loggerheads entered the benthic environment and undertook seasonal north and south migrations along the coast. However, the use of pelagic and benthic environments by loggerhead sea turtles is now suspected of being much more complex (Witzell 2002). Loggerheads may remain in the pelagic environment for longer periods of time or move back and forth between the pelagic and benthic environment (Witzell 2002). Captures of sea turtles in the U.S. pelagic longline fishery have shown that large loggerhead sea turtles (mature and/or immature) routinely inhabit offshore habitats during non-winter months in the northwest North Atlantic Ocean (Witzell 2002; Witzell 1999). It has been suggested that some of these turtles might be associated with warm water fronts and eddies and might form offshore feeding aggregations in areas of high productivity (Witzell 2002; Witzell 1999).

In 2001, NMFS (SEFSC) reviewed and updated the stock assessment for loggerhead sea turtles of the western Atlantic (NMFS SEFSC 2001). The assessment reviewed and updated information on nesting abundance and trends, estimation of vital rates, evaluation of genetic relationships between populations, and evaluation of available data on other anthropogenic effects on these populations since the TEWG reports (1998; 2000). The assessment looked at the impact of the proposed changes in the Turtle Excluder Device (TED) regulations for the shrimp fishery, as well as the U.S. pelagic longline fishery on loggerheads. NMFS SEFSC (2001) constructed models based on a 30% decrease in small benthic juvenile mortality based on research findings of (existing) TED effectiveness (Crowder *et al.* 1995; NMFS SEFSC 2001; Heppell *et al.* 2003). Model runs were then compared with respect to the change in population status as a result of implementing the requirement for larger TEDs (Epperly *et al.* 2002) alone, and also when combined with other changes in survival rate from the pelagic long line fishery. The results of the modeling indicated that the proposed change in the TED regulations which would allow larger benthic immature loggerheads and sexually mature loggerheads to escape from shrimp trawl gear would have a positive or at least stabilizing influence on the subpopulation in nearly all scenarios. Coupling the anticipated effect of the proposed TED changes with changes in the survival rate of pelagic immature loggerheads revealed that subpopulation status would be positive or at least stable. NMFS' SEFSC (2001) assessment was reviewed by three independent experts from the Center for Independent Experts, in 2001. As a result, NMFS SEFSC's stock assessment report, the reviews of it, and the body of scientific literature upon which these documents were derived represent the best available scientific and commercial information for Atlantic loggerheads.

Aerial surveys suggest that loggerheads (benthic immatures and adults) in U.S. waters are distributed in the following proportions: 54% in the southeast U.S. Atlantic, 29% in the northeast U.S. Atlantic, 12% in the eastern Gulf of Mexico, and 5% in the western Gulf of Mexico (TEWG 1998). Like other sea turtles, the movements of loggerheads are influenced by water temperature. Since they are limited by water temperatures, loggerhead sea turtles do not usually appear on the northern summer foraging grounds (e.g., in the action area) until June, but can be found in Virginia as early as April. The large majority leave the Gulf of Maine by mid-September but may remain in the Northeast and mid-Atlantic waters until as late as November or December (Epperly et al., 1995; Keinath 1993; Morreale 1999; Shoop and Kenney 1992). Loggerhead sea turtles are primarily benthic feeders, opportunistically foraging on crustaceans

and mollusks (Wynne and Schwartz, 1999). Under certain conditions they may also scavenge fish, particularly if they are easy to catch (e.g., caught in nets; NMFS and USFWS, 1991).

Threats to loggerhead recovery

The five major subpopulations of loggerhead sea turtles in the northwest Atlantic — northern, south Florida, Florida panhandle, Yucatán, and Dry Tortugas — are all subject to fluctuations in the number of young produced annually because of human-related activities as well as natural phenomena. Loggerhead sea turtles face numerous threats from natural causes. For example, there is a significant overlap between hurricane seasons in the Caribbean Sea and northwest Atlantic Ocean (June to November), and the loggerhead sea turtle nesting season (March to November). Sand accretion and rainfall that result from these storms as well as wave action can appreciably reduce hatchling success. In 1992, Hurricane Andrew affected turtle nests over a 90-mile length of coastal Florida; all of the eggs were destroyed by storm surges on beaches that were closest to the eye of this hurricane (Milton et al., 1992). On Fisher Island near Miami, Florida, 69 percent of the eggs did not hatch after Hurricane Andrew, probably because they were drowned by the storm surge. Nests from the northern nesting group were destroyed by hurricanes which made landfall in North Carolina in the mid to late 1990's. Also, reports suggest that extensive loggerhead nest destruction has occurred in Florida and other southern states in 2004 due to damage from multiple hurricanes and storm events. Other sources of natural mortality include cold stunning and biotoxin exposure.

Anthropogenic factors that impact hatchlings and adult female turtles on land, or the success of nesting and hatching include: beach erosion, beach armoring and nourishment; artificial lighting; beach cleaning; increased human presence; recreational beach equipment; beach driving; coastal construction and fishing piers; exotic dune and beach vegetation; and poaching. An increased human presence at some nesting beaches or close to nesting beaches has led to secondary threats such as the introduction of exotic fire ants, feral hogs, dogs and an increased presence of native species (e.g., raccoons, armadillos, and opossums) which raid and feed on turtle eggs. Although sea turtle nesting beaches are protected along large expanses of the northwest Atlantic coast (in areas like Merritt Island, Archie Carr, and Hobe Sound National Wildlife Refuges), other areas along these coasts have limited or no protection. Sea turtle nesting and hatching success on unprotected high density east Florida nesting beaches from Indian River to Broward County are affected by all of the above threats.

Loggerhead sea turtles are impacted by a completely different set of threats from human activities once they migrate to the ocean. Pelagic immature loggerhead sea turtles from these four subpopulations circumnavigate the North Atlantic over several years (Carr 1987, Bjorndal et al. 1994). During that period, they are exposed to a series of long-line fisheries that include the U.S. Atlantic tuna and swordfish longline fisheries, an Azorean long-line fleet, a Spanish long-line fleet, and various fleets in the Mediterranean Sea (Aguilar et al., 1995, Bolten et al., 1994, Crouse 1999). Observer records indicate that an estimated 6,544 loggerheads were captured by the U.S. Atlantic tuna and swordfish longline fleet between 1992-1998, of which an estimated 43 were dead (Yeung et al. in prep.). Logbooks and observer records indicated that loggerheads, readily ingest hooks (Witzell 1999).

In waters off the coastal U.S., loggerhead sea turtles are exposed to a suite of fisheries in Federal and State waters including trawl, purse seine, hook and line, gillnet, pound net, longline, and trap fisheries. For example, loggerhead sea turtles have been captured in fixed pound net gear in the Long Island Sound, in pound net gear and trawls in summer flounder and other finfish fisheries in the mid-Atlantic and Chesapeake Bay, and in gillnet fisheries (e.g., monkfish, spiny dogfish) in the mid-Atlantic and elsewhere. The take of sea turtles, including loggerheads, in shrimp fisheries off the Atlantic coast have been well documented. It has previously been observed that loggerhead turtle populations along the southeastern Atlantic coast declined where shrimp fishing was intense off the nesting beaches but, conversely, did not appear to be declining where nearshore shrimping effort was low or absent (National Research Council 1990).

In the pelagic environment loggerheads are exposed to a series of longline fisheries that include the U.S. Atlantic tuna and swordfish longline fisheries, an Azorean longline fleet, a Spanish longline fleet, and various fleets in the Mediterranean Sea (Aguilar et al. 1995; Bolten et al. 1994; Crouse 1999). Globally, an estimated 200,000 - 250,000 loggerhead sea turtles are estimated to have been captured in 2000 as a result of pelagic longline fisheries (Lewison et al. 2004). The effects of the U.S. tuna and swordfish longline fisheries on loggerhead sea turtles have been assessed through section 7 consultation on the Highly Migratory Species Fishery Management Plan (HMS FMP). Further information on the effects of these fisheries on loggerhead sea turtles is provided in section 4.1.1 of this document. In short, NMFS estimates that 1,869 loggerheads will be captured in the pelagic longline fishery (no more than 438 mortalities) for the 3-year period from 2004-2006. For each subsequent 3-year period, 1,905 loggerheads are expected to be taken with no more than 339 mortalities (NMFS 2004b). NMFS continues to work with pelagic longline fishers on gear modifications to help minimize turtle interactions with longline gear.

In the benthic environment in waters off the coastal U.S., loggerheads are exposed to a suite of fisheries in federal and state waters including trawl, purse seine, hook and line, gillnet, pound net, longline, and trap fisheries. Perhaps the most well documented U.S. fishery with respect to interactions with sea turtles, including loggerheads, is the U.S. shrimp fishery. NMFS continues to address the effects of this fishery on loggerheads as well as other sea turtle species. Turtle Excluder Devices have proven to be effective at excluding Kemp's ridley sea turtles and some age classes of loggerhead and green sea turtles from shrimp trawls. However, it was apparent that TEDs were not effective at excluding large benthic immature and sexually mature loggerheads (as well as large greens). Therefore, on February 21, 2003, NMFS issued a final rule that required increasing the size of TED escape openings to allow larger loggerheads (and green sea turtles) to escape from shrimp trawl gear. As a result of the new rules, annual loggerhead mortality as a result of capture in shrimp trawls is expected to decline from 62,294 to 3,947 turtles (Epperly et al. 2002). Additional information is provided in section 4.1.1 of this Opinion regarding loggerhead turtle interactions with U.S. fisheries within the action area.
In addition to fishery interactions, loggerhead sea turtles also face other threats in the marine environment, including the following: oil and gas exploration, development, and transportation; marine pollution; underwater explosions; hopper dredging, offshore artificial lighting; power

plant entrainment and/or impingement; entanglement in debris; ingestion of marine debris; marina and dock construction and operation; boat collisions; and poaching.

Status and trend of loggerhead sea turtles
The loggerhead sea turtle is listed throughout its range as threatened under the ESA. In the Pacific Ocean, loggerhead turtles are represented by a northwestern Pacific nesting aggregation (located in Japan) and a smaller southwestern nesting aggregation that occurs in Australia (Great Barrier Reef and Queensland), New Caledonia, New Zealand, Indonesia, and Papua New Guinea. The abundance of loggerhead turtles on nesting colonies throughout the Pacific basin have declined dramatically over the past 10 to 20 years by the combined effects of human activities that have reduced the number of nesting females and reduced the reproductive success of females that manage to nest (*e.g.*, due to egg poaching).

There are at least five western Atlantic loggerhead subpopulations (NMFS SEFSC 2001; TEWG 2000; Márquez 1990). Cohorts from three of these, the south Florida, Yucatán, and northern subpopulations, are known to occur within the action area of this consultation (Bass *et al.* 1998; Rankin-Baransky *et al.* 2001). The south Florida nesting group is the largest known loggerhead nesting assemblage in the Atlantic and one of only two loggerhead nesting assemblages worldwide that have greater than 10,000 females nesting per year (USFWS and NMFS 2003; USFWS Fact Sheet). The northern subpopulation is the second largest loggerhead nesting assemblage within the United States. Nesting data through 2003, indicate that there is no discernable trend in the south Florida or northern nesting subpopulation (Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute, Statewide and Index Nesting Beach Survey Programs; USFWS and NMFS 2003). The remaining three subpopulations (the Dry Tortugas, Florida Panhandle, and Yucatán) are much smaller subpopulations but no less relevant to the continued existence of the species. The most recent nesting data indicates that there are no detectable trends in the status of nesting for these subpopulations (Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute, Statewide Nesting Beach Survey Data).

Several published reports have presented the problems facing long-lived species that delay sexual maturity (Crouse et al., 1987, Crowder et al., 1994, Crouse 1999). In general, these reports concluded that animals that delay sexual maturity and reproduction must have high annual survival as juveniles through adults to ensure that enough juveniles survive to reproductive maturity and then reproduce enough times to maintain stable population sizes. This general rule applies to sea turtles, particularly loggerhead sea turtles, as the rule originated in studies of sea turtles (Crouse et al., 1987, Crowder et al., 1994, Crouse 1999). Crouse (1999) concluded that relatively small decreases in annual survival rates of both juvenile and adult loggerhead sea turtles will adversely affect large segments of the total loggerhead sea turtle population. The survival of hatchlings seems to have the least amount of influence on the survivorship of the species, but historically, the focus of sea turtle conservation has been involved with protecting the nesting beaches. While nesting beach protection and hatchling survival are important, recovery efforts and limited resources might be more effective by focusing on the protection of juvenile and adult sea turtles.

Green sea turtle

Green turtles are the largest chelonid (hard-shelled) sea turtle, with an average adult carapace of 91 cm SCL and weight of 150 kg. Ninety percent of green turtles found in Long Island Sound are between 25 and 40 cm SCL, with the largest reported being 68 cm (Burke et al. 1991). Based on growth rate studies of wild green turtles, greens have been found to grow slowly with an estimated age of sexual maturity ranging from 18 to 40 years (Balazs 1982, Frazer and Ehrhard 1985 in NMFS and USFWS 1991a, B. Schroeder pers. comm.). In 1978, the Atlantic population of the green sea turtle was listed as threatened under the ESA, except for the breeding populations in Florida and on the Pacific coast of Mexico, which were listed as endangered. As it is difficult to differentiate between breeding populations away from the nesting beaches, all green sea turtles, in water, are considered endangered.

Green turtles are distributed circumglobally. In the western Atlantic they range from Massachusetts to Argentina, including the Gulf of Mexico and Caribbean (Wynne and Schwartz, 1999). As is the case for loggerhead and Kemp's ridley sea turtles, green sea turtles use mid-Atlantic and northern areas of the western Atlantic Ocean as important summer developmental habitat. Green turtles are found in estuarine and coastal waters as far north as Long Island Sound, Chesapeake Bay, and North Carolina sounds (Musick and Limpus 1997). Like loggerheads and Kemp's ridleys, green sea turtles that use northern waters during the summer must return to warmer waters when water temperatures drop, or face the risk of cold stunning. Cold stunning of green turtles may occur in southern areas as well (i.e., Indian River, Florida), as these natural mortality events are dependent on water temperatures and not solely geographical location.

In the continental U.S. green turtle nesting occurs on the Atlantic coast of Florida (Ehrhart 1979). Occasional nesting has been documented along the Gulf coast of Florida, at southwest Florida beaches, as well as the beaches on the Florida Panhandle (Meylan et al., 1995). Certain Florida nesting beaches where most green turtle nesting activity occurs have been designated index beaches. Index beaches were established to standardize data collection methods and effort on key nesting beaches. The pattern of green turtle nesting shows biennial peaks in abundance, with a generally positive trend during the ten years of regular monitoring since establishment of the index beaches in 1989, perhaps due to increased protective legislation throughout the Caribbean (Meylan et al., 1995). Recently, green turtle nesting occurred on Bald Head Island, North Carolina just east of the mouth of the Cape Fear River, on Onslow Island, and on Cape Hatteras National Seashore. Increased nesting has also been observed along the Atlantic Coast of Florida, on beaches where only loggerhead nesting was observed in the past (Pritchard 1997). Population estimates for green turtles in the western Atlantic area are not available.

The remaining portion of the green turtle's life is spent on the foraging and breeding grounds. Juvenile green sea turtles occupy pelagic habitats after leaving the nesting beach. Pelagic juveniles are assumed to be omnivorous, but with a strong tendency toward carnivory during early life stages. At approximately 20 to 25 cm carapace length, juveniles leave pelagic habitats and enter benthic foraging areas, shifting to a chiefly herbivorous diet (Bjorndal 1997). Green

turtles appear to prefer marine grasses and algae in shallow bays, lagoons and reefs (Rebel 1974), but also consume jellyfish, salps, and sponges. Some of the principal feeding pastures in the western Atlantic Ocean include the upper west coast of Florida and the northwestern coast of the Yucatan Peninsula. Additional important foraging areas in the western Atlantic include the Mosquito and Indian River Lagoon systems and nearshore wormrock reefs between Sebastian and Ft. Pierce Inlets in Florida, Florida Bay, the Culebra archipelago and other Puerto Rico coastal waters, the south coast of Cuba, the Mosquito Coast of Nicaragua, the Caribbean Coast of Panama, and scattered areas along Colombia and Brazil (Hirth 1971). Important summer development areas are located along the western north Atlantic in shallow embayments and estuaries, including the Chesapeake Bay and as far north as Long Island Sound.

Threats to green turtle recovery
Green turtles were traditionally highly prized for their flesh, fat, eggs, and shell, and directed fisheries in the United States and throughout the Caribbean are largely to blame for the decline of the species. In the Gulf of Mexico, green turtles were once abundant enough in the shallow bays and lagoons to support a commercial fishery. In 1890, over one million pounds of green turtles were taken in the Gulf of Mexico green sea turtle fishery (Doughty 1984). However, declines in the turtle fishery throughout the Gulf of Mexico were evident by 1902 (Doughty 1984).

Fibropapillomatosis, an epizootic disease producing lobe-shaped tumors on the soft portion of a turtle's body, has been found to infect green turtles, most commonly juveniles. The occurrence of fibropapilloma tumors, most frequently documented in Hawaiian green turtles, may result in impaired foraging, breathing, or swimming ability, leading potentially to death.

Green turtles continue to be heavily exploited by man, with the degradation of nesting and foraging habitats, incidental capture in fisheries, and marine pollution acknowledged as serious hindrances to species recovery. As with the other sea turtle species, fishery mortality accounts for a large proportion of annual anthropogenic mortality outside the nesting beaches, while other activities like dredging, pollution, and habitat destruction account for an unknown level of mortality. Sea sampling coverage in the pelagic driftnet, pelagic longline, scallop dredge, southeast shrimp trawl, and summer flounder bottom trawl fisheries has recorded takes of green turtles. Stranding reports indicate that between 200-400 green turtles strand annually along the Eastern U.S. coast from a variety of causes, most of which are unknown (Sea Turtle Stranding and Salvage Network, unpublished data).

Status and trends of green sea turtles
The Atlantic population of the green sea turtle was listed as threatened under the ESA in 1978, except for the breeding populations in Florida and on the Pacific coast of Mexico, which were listed as endangered. While away from the nesting beaches all Atlantic green sea turtles are considered endangered. In the western Atlantic they range from Massachusetts to Argentina, including the Gulf of Mexico and Caribbean (Wynne and Schwartz, 1999). As is the case for loggerhead and Kemp's ridley sea turtles, green sea turtles use mid-Atlantic and northern areas of the western Atlantic Ocean as important summer developmental habitat. Green turtles are

found in estuarine and coastal waters as far north as Long Island Sound, Chesapeake Bay, and North Carolina sounds (Musick and Limpus 1997).

In the continental U.S. green turtle nesting occurs along the Atlantic coast of Florida, and occasional nesting has been documented along the Gulf coast of Florida, at southwest Florida beaches, as well as the beaches on the Florida Panhandle (Meylan et al., 1995). Data collected at index beaches shows a generally positive trend during the years of regular monitoring since establishment of the index beaches in 1989. Recent population estimates for green turtles in the western Atlantic area are not available.

Green turtles are subject to several threats throughout their lifetimes, which have led to the decline in population size. Green turtles were traditionally highly prized for their flesh, fat, eggs, and shell, and directed fisheries in the United States and throughout the Caribbean are largely to blame for the decline of the species. In addition to harvesting turtles, the degradation of nesting and foraging habitats, incidental capture in fisheries and marine pollution are all effects humans have had on green populations. Disease such as fibropapillomatosis, an epizootic disease producing lobe-shaped tumors on the soft portion of a turtle's body, has been found to infect green turtles, most commonly juveniles have also lead to the decline of the species.

Kemp's ridley sea turtle

The Kemp's ridley is the most endangered of the world's sea turtle species. Of the world's seven extant species of sea turtles, the Kemp's ridley has declined to the lowest population level. The Kemp's ridley sea turtle was listed as endangered throughout its range on December 2, 1970 under United States law. The Kemp's ridley is now protected under the ESA. Kemp's ridleys nest primarily on Rancho Nuevo in Tamaulipas, Mexico, where nesting females emerge synchronously during the day to nest in aggregations known as arribadas. Most of the population of adult females nest in this single locality (Pritchard 1969).

During the 1940's over 40,000 females were nesting at Rancho Nuevo in a single arribada (USFWS 2003). Due to several factors, discussed in the following sections, the number of nesting females drastically declined, and in 1966 a monitoring program was initiated. During the year 1969 it was estimated that over 5,000 females nested at Rancho Nuevo that season (Marquez-M *et al.*, 2001). The number of nesting females declined severely through the next decades to an average of approximately 740 nests during the 1985 to 1987 nesting seasons (Marquez-M *et al.*, 2001). As conservation efforts continued, the numbers of nesting females have slowly begun to increase. Over 3,000 nests were observed during the 2000 nesting season (Marquez-M *et al.*, 2001), and according to the U.S. Fish and Wildlife Service Fact Sheet, 2003 for the Kemp's ridley sea turtle, more than 6,436 nests were observed during the 2002 nesting season and 8,288 nests were observed during the 2003 nesting season.

Kemp's ridley nesting occurs from April through July each year. Little is known about mating but it is believed to occur at or before the nesting season in the vicinity of the nesting beach. Hatchlings emerge after 45-58 days. Once they leave the beach, neonates presumably enter the Gulf of Mexico where they feed on available sargassum and associated infauna or other

epipelagic species (USFWS and NMFS, 1992). Research conducted by Texas A&M University has resulted in the intentional live-capture of hundreds of Kemp's ridleys at Sabine Pass and the entrance to Galveston Bay. Between 1989 and 1993, 50 of the Kemp's ridleys captured were tracked (using satellite and radio telemetry) by biologists with the NMFS Galveston Laboratory. The tracking study was designed to characterize sea turtle habitat and to identify small and large scale migration patterns. Preliminary analysis of the data collected during these studies suggests that subadult Kemp's ridleys stay in shallow, warm, nearshore waters in the northern Gulf of Mexico until cooling waters force them offshore or south along the Florida coast (Renaud, NMFS Galveston Laboratory, pers. comm.). Ogren (1988) suggests that the Gulf coast, from Port Aransas, Texas, through Cedar Key, Florida, represents the primary habitat for subadult ridleys in the northern Gulf of Mexico. However, at least some juveniles will travel northward as water temperatures warm to feed in productive coastal waters of Georgia through New England (USFWS and NMFS, 1992).

Juvenile Kemp's ridleys use northeastern and mid-Atlantic coastal waters of the U.S. Atlantic coastline as primary developmental habitat during summer months, with shallow coastal embayments serving as important foraging grounds. Ridleys found in mid-Atlantic waters are primarily post-pelagic juveniles averaging 40 cm in carapace length, and weighing less than 20 kg (Terwilliger and Musick 1995). Next to loggerheads, they are the second most abundant sea turtle in mid-Atlantic waters, arriving in these areas during late May and June (Keinath et al., 1987; Musick and Limpus, 1997). In the Chesapeake Bay, where the juvenile population of Kemp's ridley sea turtles is estimated to be 211 to 1,083 turtles (Musick and Limpus 1997), ridleys frequently forage in shallow embayments, particularly in areas supporting submerged aquatic vegetation (Lutcavage and Musick 1985; Bellmund et al., 1987; Keinath et al., 1987; Musick and Limpus 1997). Other studies have found that post-pelagic ridleys feed primarily on crabs, consuming a variety of species. Mollusks, shrimp, and fish are consumed less frequently (Bjorndal 1997).

With the onset of winter and the decline of water temperatures, Kemp's ridleys migrate to more southerly waters from September to November (Keinath et al. 1987; Musick and Limpus 1997). Turtles that do not head south before water temperatures drop rapidly face the risk of cold-stunning. Cold stunning can be a significant natural cause of mortality for sea turtles in Cape Cod Bay and Long Island Sound. For example, in the winter of 1999/2000, there was a major cold-stunning event where 218 Kemp's ridleys, 54 loggerheads, and 5 green turtles were found on Cape Cod beaches (R. Prescott, pers. comm.). Annual cold stun events only occasionally occur at this magnitude; the extent of episodic major cold stun events may be associated with numbers of turtles utilizing Northeast waters in a given year, oceanographic conditions and the occurrence of storm events in the late fall. During the winter of 2001/2002, 88 Kemp's ridleys cold stunned on Cape Cod beaches, 186 ridleys cold stunned on Cape Cod during 2002/2003, 79 cold stunned during 2003/2004, and only 32 cold stunned on Cape Cod during the 2004/2005 winter season (R. Prescott, pers. comm.). Cold stunned turtles have also been reported on beaches in New York and New Jersey (Morreale et al., 1992). Although cold stun turtles can survive if found early enough, cold stunning events can represent a significant cause of natural mortality.

From telemetry studies, Morreale and Standora (1994) determined that Kemp's ridleys are sub-surface animals that frequently swim to the bottom while diving. The generalized dive profile showed that the turtles spend 56% of their time in the upper third of the water column, 12% in mid-water, and 32% on the bottom. In water shallower than 15 m (50 ft), the turtles dive to depth, but spend a considerable portion of their time in the upper portion of the water column. In contrast, turtles in deeper water dive to depth, spending as much as 50% of the dive on the bottom.

Threats to Kemp's ridley recovery

Like other turtle species, the severe decline in the Kemp's ridley population appears to have been heavily influenced by a combination of exploitation of eggs and impacts from fishery interactions. From the 1940's through the early 1960's, nests from Ranch Nuevo were heavily exploited (USFWS and NMFS, 1992), but beach protection in 1966 helped to curtail this activity (USFWS and NMFS, 1992). Currently, anthropogenic impacts to the Kemp's ridley population are similar to those discussed above for other sea turtle species. Sea sampling coverage in the Northeast otter trawl fishery, pelagic longline fishery, and southeast shrimp and summer flounder bottom trawl fisheries have recorded takes of Kemp's ridley turtles. Following World War II, there was a substantial increase in the number of trawl vessels, particularly shrimp trawlers, in the Gulf of Mexico where the adult Kemp's ridley turtles occur. Information from fishers helped to demonstrate the high number of turtles taken in these shrimp trawls (USFWS and NMFS, 1992). Subsequently, NMFS has worked with the industry to reduce turtle takes in shrimp trawls and other trawl fisheries, including the development and use of Turtle Excluder Devices (TEDs).

Kemp's ridleys may also be affected by large-mesh gillnet fisheries. In the spring of 2000, a total of five Kemp's ridley carcasses were recovered from the same North Carolina beaches where 277 loggerhead carcasses were found. Cause of death for most of the turtles recovered was unknown, but the mass mortality event was suspected to have been from a large-mesh gillnet fishery operating offshore in the preceding weeks. The five ridley carcasses that were found are likely to have been only a minimum count of the number of Kemp's ridleys that were killed or seriously injured as a result of the fishery interaction since it is unlikely that all of the carcasses washed ashore. It is possible that strandings of Kemp's ridley turtles in some years have increased at rates higher than the rate of increase in the Kemp's ridley population (TEWG 1998).

Status and trends of Kemp's ridley sea turtles

When nesting aggregations at Rancho Nuevo were discovered in 1947, adult female populations were estimated to be in excess of 40,000 individuals (Hildebrand 1963), but the population has been drastically reduced from these historical numbers. However, the TEWG (1998; 2000) indicated that the Kemp's ridley population appears to be in the early stage of exponential expansion. Nesting data, estimated number of adults, and percentage of first time nesters have all increased from lows experienced in the 1970's and 1980's. The number of nesting females has increased from an average of approximately 740 nests during the 1985 to 1987 nesting seasons (Marquez-M *et al.*, 2001), to over 8,288 nests during the 2003 season. This level of increase allows for cautious optimism that the population is on its way to recovery. For example,

data from nests at Rancho Nuevo, North Camp and South Camp, Mexico, have indicated that the number of adults declined from a population that produced 6,000 nests in 1966 to a population that produced 924 nests in 1978 and 702 nests in 1985 then increased to produce 1,940 nests in 1995 and about 3,400 nests in 1999, and up to over 8,000 in 2003. Estimates of adult abundance followed a similar trend from an estimate of 9,600 in 1966 to 1,050 in 1985 and 3,000 in 1995. The increased recruitment of new adults is illustrated in the proportion of neophyte, or first time nesters, which has increased from 6% to 28% from 1981 to 1989 and from 23% to 41% from 1990 to 1994.

The TEWG (1998) developed a population model to evaluate trends in the Kemp's ridley population through the application of empirical data and life history parameter estimates chosen by the TEWG. Model results identified three trends in benthic immature Kemp's ridleys. Benthic immatures are those turtles that are not yet reproductively mature but have recruited to feed in the nearshore benthic environment where they are available to nearshore mortality sources that often result in strandings. Benthic immature ridleys are estimated to be 2-9 years of age and 20-60 cm in length. Increased production of hatchlings from the nesting beach beginning in 1966 resulted in an increase in benthic ridleys that leveled off in the late 1970s. A second period of increase followed by leveling occurred between 1978 and 1989 as hatchling production was further enhanced by the cooperative program between the USFWS and Mexico's Instituto Nacional de Pesca to increase the nest protection and relocation program in 1978. A third period of steady increase, which has not leveled off to date, has occurred since 1990 and appears to be due to the greatly increased hatchling production and an apparent increase in survival rates of immature turtles beginning in 1990 due, in part, to the introduction of TEDs.

The population model in the TEWG report projected that Kemp's ridleys could reach the intermediate recovery goal identified in the Recovery Plan, of 10,000 nesters by the year 2020 if the assumptions of age to sexual maturity and age specific survivorship rates plugged into their model are correct. The TEWG (1998) identified an average Kemp's ridley population growth rate of 13% per year between 1991 and 1995. Total nest numbers have continued to increase. However, the 1996 and 1997 nest numbers reflected a slower rate of growth, while the increase in the 1998 nesting level has been much higher and decreased in 1999. The population growth rate does not appear as steady as originally forecasted by the TEWG, but annual fluctuations, due in part to irregular inter-nesting periods, are normal for other sea turtle populations. Also, as populations increase and expand, nesting activity would be expected to be more variable.

One area for caution in the TEWG findings is that the area surveyed for ridley nests in Mexico was expanded in 1990 due to destruction of the primary nesting beach by Hurricane Gilbert. Because systematic surveys of the adjacent beaches were not conducted prior to 1990, there is no way to determine what proportion of the nesting increase documented since that time is due to the increased survey effort rather than an expanding ridley nesting range. The TEWG (1998) assumed that the observed increases in nesting, particularly since 1990, was a true increase rather than the result of expanded beach coverage. As noted by TEWG, trends in Kemp's ridley nesting even on the Rancho Nuevo beaches alone suggest that recovery of this population has

begun but continued caution is necessary to ensure recovery and to meet the goals identified in the Kemp's Ridley Recovery Plan.

ENVIRONMENTAL BASELINE

By regulation, environmental baselines for biological opinions include the past and present impacts of all State, Federal or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process (50 CFR §402.02). The environmental baseline for this biological opinion includes the effects of several activities that affect the survival and recovery of threatened and endangered species in the action area. Within the action area, sea turtles and optimal turtle habitat may likely have been impacted by vessel collisions, previous dredging projects, fisheries, and pollution.

Collisions with vessels, from both commercial and recreational sources, is a potential contributor to sea turtle mortality in the action area. Fifty to 500 loggerheads and 5 to 50 Kemp's ridley turtles are estimated to be killed by vessel traffic per year in the U.S. (National Research Council 1990). Although some of these strikes may be post-mortem, the data show that vessel traffic is a substantial cause of sea turtle mortality. The Intracoastal Waterway traverses the length of Barnegat Bay, and numerous recreational boaters and commercial fishing boats travel this waterway. The Intracoastal Waterway is maintained at a depth of approximately 2 meters by the Army Corps of Engineers, but the greatest depths in Barnegat Bay of 3 to 4 meters occur along this area. Vessel traffic occurs in the action area, specifically in the thermal plume region that extends from Oyster Creek into Barnegat Bay. As turtles may be in the area where high vessel traffic occurs, the potential exists for collisions with vessels transiting from within the action area into the main waters of Barnegat Bay.

Dredging activities have the ability to impact sea turtles by entraining and killing turtles and by disrupting their habitat. Sea turtle mortality in hopper dredging operations occurs when the turtles are sucked into the dredge draghead, pumped through the intake pipe and then killed as they cycle through the centrifugal pump and into the hopper. The depth of the Intracoastal Waterway, located in the action area, must be maintained for navigational purposes, resulting in dredging being conducted in the action area. Previous dredging activities conducted to develop and maintain the channel may have impacted sea turtles. Furthermore, the Barnegat Inlet, the only tidal inlet in the vicinity of Oyster Creek which provides access to Barnegat Bay from the Atlantic Ocean (and the probable pathway for turtles moving to the OCNGS), was deepened during dredging operations in the early 1990s. Sea turtles were not documented at OCNGS until 1992, after Barnegat Inlet was dredged, and it is likely that this deepening provided access for sea turtles to enter the action area. Thus, due to the dredging of Barnegat Inlet, sea turtles are now found in the vicinity of the OCNGS and are more likely to be impinged at the intakes. Maintenance dredging of Barnegat Inlet has not occurred since the 1992 initial dredging. While there have been no takes documented in any dredging activities conducted in the action area, sea turtles may have been impacted by dredging operations, including direct injury or morality, the

resuspension of sediments potentially containing contaminants, and the alteration of foraging habitat.

A variety of *commercial and recreational fisheries* occur in the action area, producing valuable input into the local economy. Commercially important finfish and shellfish species occurring in the Barnegat Bay include the American eel, alewife, bluefish, striped bass, summer flounder, winter flounder, weakfish, blue crab, horseshoe crab, and hard clam (Barnegat Bay Estuary Program 2001). Several recreational fisheries exist in the action area as well, most notably for bluefish, striped bass, summer flounder, winter flounder, weakfish, black sea bass, and tautog. Fishing gear has been found to entangle and/or hook sea turtles, which can lead to mortality if the sea turtle cannot surface for air. Throughout their range, sea turtles have been taken in different types of gear, including gillnet, pound net, rod and reel, trawl, pot and trap, longline, and dredge gear. There have been no documented takes of sea turtles in any of the fisheries in Barnegat Bay, but it is not known to what degree the various fisheries interact with turtles. Thus, sea turtles may interact and be affected by any of these commercial or recreational fisheries.

Approximately 28% of the Barnegat Bay watershed is developed (residential, commercial, industrial, and institutional), while 46% is forested land. Barnegat Bay supports a thriving tourist industry, with boating, fishing, swimming, and hunting being top recreational activities. The developed land around the Bay may contribute to marine pollution which may in turn impact sea turtles. *Marine debris* (e.g., discarded fishing line or lines from boats) can entangle turtles in the water and drown them. Turtles commonly ingest plastic or mistake debris for food.

Chemical contaminants may occur in the action area largely as a result of nonpoint source pollution. The Barnegat Bay Estuary Program has data on trace metals and radionuclides in the Barnegat Bay, but other toxic chemical contaminants may also occur in the action area including halogenated hydrocarbons and polycyclic aromatic hydrocarbons (PAHs). The Barnegat Bay estuary may be more susceptible to toxic chemical contaminants than may other estuaries because of its limited dilution capacity and flushing rate (Barnegat Bay Estuary Program 2001). These chemical contaminants may have an effect on sea turtle reproduction and survival. While the effects of contaminants on turtles is relatively unclear, pollutants may also make sea turtles more susceptible to disease by weakening their immune systems.

Reducing Threats to ESA-listed Sea Turtles

Sea Turtle Stranding and Salvage Network (STSSN) is an extensive network of participants along the Atlantic and Gulf of Mexico coasts which not only collects data on dead sea turtles, but also rescues and rehabilitates live stranded turtles. Data collected by the STSSN are used to monitor stranding levels and identify areas where unusual or elevated mortality is occurring. These data are also used to monitor incidence of disease, study toxicology and contaminants, and conduct genetic studies to determine population structure. All of the states that participate in the STSSN tag live turtles when encountered (either via the stranding network through incidental takes or in-water studies). Tagging studies help provide an understanding of sea turtle movements, longevity, and reproductive patterns, all of which contribute to our ability to reach recovery goals for the species. The Marine Mammal Stranding Center, located in Brigantine, NJ which

participates in the STSSN has routinely been involved in the necropsy of dead turtles and the tagging and release of live turtles which have been impinged or entrained at the OCNGS.

Sea Turtle Handling and Resuscitation Techniques - NMFS has developed and published as a final rule in the *Federal Register* (66 FR 67495, December 31, 2001), specific sea turtle handling and resuscitation techniques for sea turtles that are incidentally caught during scientific research or fishing activities. Persons participating in fishing activities or scientific research are required to take these measures to help prevent mortality of turtles caught in fishing or scientific research gear.

Summary and Synthesis of the status of the Species and Environmental Baseline.
The environmental baseline evaluates the impacts of actions sea turtles have been and continue to be exposed to in the action area, and identifies the status of the species in the action area. The sea turtles likely to be found in the action area, loggerheads, Kemp's ridley, and green sea turtles are typically small juveniles with the most abundant being the federally threatened loggerhead followed by the federally endangered Kemp's ridley, and green sea turtles. The available information on the impacts does not permit the specific itemization of the numbers of lethal and non-lethal interactions between sea turtles and various activities in the action area. However, available information also does not suggest that the types of activities falling with the definition the environmental baseline are unique to the action area, or that the aggregate impacts of those activities is unique compared to other areas. The lack of information also prevents an estimate of numbers of sea turtles of each species likely to be in the action area, although it is expected to be significantly less than the total population given the broad distribution of each species.

All sea turtles are affected by a number of anthropogenic and natural effects. Anthropogenic effects include fishing gear associated with fisheries in State, Federal and international waters; poaching, development and erosion on their nesting beaches. In the area surrounding the action area, sea turtles may be captured, injured or killed in interactions with fishing gear such as gillnets and trawls, or they may be injured or killed as a result vessel strike. Although it is impossible to quantify the impact of these activities, nesting data suggests that the populations of Loggerheads, Kemp's ridleys and possibly green sea turtles are increasing despite the cumulative effects of these impacts.

Loggerhead Sea Turtles
The loggerhead sea turtle is listed throughout its range as threatened under the ESA. In the Pacific Ocean, loggerhead turtles are represented by a northwestern Pacific nesting aggregation (located in Japan) and a smaller southwestern nesting aggregation that occurs in Australia (Great Barrier Reef and Queensland), New Caledonia, New Zealand, Indonesia, and Papua New Guinea. In the Atlantic Ocean, there are at least five loggerhead subpopulations (NMFS SEFSC 2001; TEWG 2000; Márquez 1990). Cohorts from three of these, the south Florida, Yucatán, and northern subpopulations, are likely to occur within the action area.

Several published reports have presented the problems facing long-lived species, such as loggerheads, that delay sexual maturity (Crouse et al., 1987, Crowder et al., 1994, Crouse 1999). In general, animals that delay sexual maturity and reproduction must have high annual survival

as juveniles through adults to ensure that enough juveniles survive to reproductive maturity and then reproduce enough times to maintain stable population sizes. The survival of hatchlings seems to have the least amount of influence on the survivorship of the species, but historically, the focus of sea turtle conservation has been involved with protecting the nesting beaches. While nesting beach protection and hatchling survival are important, recovery efforts and limited resources might be more effective by focusing on the protection of juvenile and adult sea turtles.

Kemp's Ridley Sea Turtles

The Kemp's ridley is the most endangered of the world's sea turtle species. The only major nesting site for ridleys is a single stretch of beach near Rancho Nuevo, Tamaulipas, Mexico (Carr 1963). When nesting aggregations at Rancho Nuevo were discovered in 1947, adult female populations were estimated to be in excess of 40,000 individuals (Hildebrand 1963), but the population has been drastically reduced from these historical numbers. However, the TEWG (1998; 2000) indicated that the Kemp's ridley population appears to be in the early stage of exponential expansion. Nesting data, estimated number of adults, and percentage of first time nesters have all increased from lows experienced in the 1970's and 1980's. The number of nesting females has increased from an average of approximately 740 nests during the 1985 to 1987 nesting seasons (Marquez-M *et al.*, 2001), to over 8,288 nests during the 2003 season.

Green Sea Turtles

The Atlantic population of the green sea turtle was listed as threatened under the ESA in 1978, except for the breeding populations in Florida and on the Pacific coast of Mexico, which were listed as endangered. While away from the nesting beaches all Atlantic green sea turtles are considered endangered. In the western Atlantic they range from Massachusetts to Argentina, including the Gulf of Mexico and Caribbean (Wynne and Schwartz, 1999). In the continental U.S. green turtle nesting occurs along the Atlantic coast of Florida, and occasional nesting has been documented along the Gulf coast of Florida, at southwest Florida beaches, as well as the beaches on the Florida Panhandle (Meylan et al., 1995). Data collected at index beaches shows a generally positive trend during the years of regular monitoring since establishment of the index beaches in 1989. Population estimates for green turtles in the western Atlantic area are not available.

Green turtles are subject to several threats throughout their lifetimes, which have led to the decline in population size. Green turtles were traditionally highly prized for their flesh, fat, eggs, and shell, and directed fisheries in the United States and throughout the Caribbean are largely to blame for the decline of the species. In addition to harvesting turtles, the degradation of nesting and foraging habitats, incidental capture in fisheries and marine pollution are all effects humans have had on green populations. Disease such as fibropapillomatosis, an epizootic disease producing lobe-shaped tumors on the soft portion of a turtle's body, has been found to infect green turtles, most commonly juveniles have also lead to the decline of the species.

EFFECTS OF THE ACTION

In this section of a biological opinion, NMFS assesses the direct and indirect effects of the proposed action on threatened and endangered species or critical habitat, together with the effects

of other activities that are interrelated or interdependent (50 CFR §402.02). Indirect effects are those that are caused later in time, but are still reasonably certain to occur. 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). The purpose of this assessment is to determine if it is reasonable to expect the NRC's proposed action to have direct or indirect effects on threatened and endangered species that appreciably reduce their likelihood of both the survival and recovery in the wild by reducing the reproduction, numbers or distribution of the species. [Which is the "jeopardy" standard established by 50 CFR §402.02].

The proposed action is likely to adversely affect threatened and endangered sea turtles in four different ways: (A) impingement at either the CWS or DWS intake trash racks; (B) alteration of sea turtle distribution or sea turtle prey abundance from the thermal discharge; (C) cold stunning relating to the thermal discharge; and (D) impacts from the chlorine used at the OCNGS.

A) Impingement of Sea Turtles

Power plants with intake structures have the potential to impinge sea turtles, resulting in mortality if the turtles are not recovered within a sufficient amount of time. Both live and dead sea turtles have been found impinged at the OCNGS in the past, at both the DWS and CWS intakes. The problem with this impingement is that a turtle could be caught against the grate underwater by the current long enough to cause suffocation or drowning. Plant personnel estimated that many of the turtles that were taken at OCNGS had been impinged for up to 8 hours. In some natural situations, turtles may remain submerged for several hours. However, stress dramatically decreases the amount of time a turtle can stay submerged. For example, trawl times for shrimpers in the southeast are limited by regulation to 55 minutes in the summer months and 75 minutes in the winter months, due to the fact that there is a strong positive correlation between tow time and incidence of sea turtle death (Henwood and Stuntz 1987, Stebenau and Vietti 2000). Under conditions of involuntary or forced submergence, sea turtles maintain a high level of energy consumption, which rapidly depletes their oxygen store and can result in large, potentially harmful internal changes (Magnuson et al. 1990). Those changes include a substantial increase in blood carbon dioxide, increases in epinephrine and other hormones associated with stress, and severe metabolic acidosis caused by high lactic acid concentrations. In forced submergence, a turtle becomes exhausted and then comatose; it will die if submergence continues. Physical and biological factors that increase energy consumption, such as high water temperature and increased metabolic rates characteristic of small turtles, would be expected to exacerbate the harmful effects of forced submergence. Other factors, such as the level of dissolved oxygen in the water, the activity of the turtle and whether or not it has food in its stomach, may also affect the length of time it may stay submerged. It is likely that sea turtles impinged on the intake trash bars are stressed, and these conditions may increase the turtles' susceptibility to suffocation or drowning.

If a sea turtle is impinged on the intake trash bars, drowning will be the most likely cause of mortality or injury, but the sea turtle could also become injured by the operation of the facility. Debris is cleaned from the intake trash bars by a trash rake which is moved on a track from one bay to the next. The rake, a horizontal array of large curved tines, is lowered down into the bay

to remove debris from the intake gratings. When the rake reaches the desired depth, the tines are deployed, curving downward to penetrate through the grate before the rake is raised. This process could cause serious injury to a turtle. Scrapes on a turtle's carapace could also result from interactions with the intake trash bars, or during rescue and retrieval by OCNGS personnel.

In addition to injury and mortality, impingement at the OCNGS intake could result in the interruption of migration and the eventual loss of nesting opportunities. Sea turtles migrate to northeastern waters when the waters warm in the late spring and early summer, returning south in the late fall. While turtles may be in the action area for foraging purposes, it is possible that turtles are migrating through the area in the spring on their way to more suitable foraging habitats in the Northeast, or in the fall on their way to overwintering areas. Thus, if impingement impedes this migration, this would affect typical sea turtle migration and/or foraging patterns. Most of the sea turtles found at OCNGS are juveniles and are not partaking in nesting. However, if impingement results in mortality, these animals would not nest in the future and would not subsequently contribute to the population.

Debris floating on the surface could make it more difficult to spot a turtle below, particularly if the turtle was flush against the grating. A small amount of debris may not be enough to block the flow and necessitate use of trash rakes, but could hide a turtle. In addition, visibility at the intake bays, which are 15 (DWS) to 18 (CWS) feet deep, is only 2-3 feet. Although at least one of the impinged turtles was found alive with its head out of the water, a turtle that is impinged at depth could remain out of sight until the trash rake was lowered to it. It is possible that a turtle could swim into the intake bay, encounter the grating, and swim down along the grating to a depth below the view of surface observers. If a turtle is feeding on the bottom of the intake canal, its first encounter with the intake grating could be at depth.

It is unclear why sea turtles enter the Forked River and encounter the OCNGS intake structures. Turtles could be attracted to the intake screens when prey items such as blue crabs and horseshoe crabs are gathered there. In 1992, one loggerhead turtle was recaptured 2 days after it was released into the discharge canal. This suggests that the turtle was attracted either to the ambient conditions in the south fork of the Forked River or to the conditions at the intake trash racks. Attractive features may be associated with the discharge as well as the intake. The warm water discharge may increase the distribution of prey species to the area, and returns of live entrained organisms or dead fish and other material dumped from the traveling screens may provide food for the turtles or scavenging prey species.

The diversion of the south fork of the Forked River may also create conditions which attract turtles to the OCNGS and therefore increase the likelihood of impingement. When the plant is operational, all flow in the south fork is diverted into the CWS and DWS intakes, so it is possible that impingements of turtles at the OCNGS could be the result of routing the entire south fork rather than of an attraction at the intake screens. The diversion also represents a reversal of flow in the south fork.

Though sea turtles are known to use New Jersey's coastal waters, no turtles were observed in Barnegat Bay in 20 years of sampling conducted by OCNGS up to 1992 and no turtles were

observed taken at the plant during the first 23 years of operation. However, the frequency and efficiency of monitoring the intakes prior to 1992 has not been determined. Incidental captures of sea turtles at OCNGS CWS and DWS cooling water intakes were documented in June of 1992 by OCNGS Environmental Controls personnel and reported to NMFS according to reporting procedures established through informal consultation conducted between OCNGS, NRC, and NMFS. Between June 1992 and July 1994, 9 sea turtle impingements occurred at the OCNGS intake trash bars, including 5 loggerheads (1 recapture) and 4 Kemp's ridleys. Three of the loggerheads and 1 of the Kemp's ridleys were recovered alive. The remaining turtles were recovered dead from the intake trash bars. The cause of death for several of the turtles recovered dead at OCNGS was left undetermined; death may have occurred prior to the turtle entering the trash racks or as a result of the facility intakes. There were no sea turtle takes observed in 1995 or 1996. One Kemp's ridley turtle was lethally taken in 1997, and one loggerhead was recovered alive in 1998. Between 1999 and 2004 at total of 22 sea turtle impingements have been documented at the OCNGS intake structures. Of these 22 turtles, 16 were Kemp's ridley, 2 were loggerheads, and 4 were green sea turtles, a total of 15 of the turtles were recovered alive. Therefore, there have been 33 total observed takes at the OCNGS since 1969, including 21 Kemp's ridleys, 8 loggerheads (which includes 1 recapture), and 4 greens. The details of those takes are outlined in Appendix I.

The number of sea turtles collected at the OCNGS CWS and DWS intakes per year has ranged from zero (from 1969 to 1991, 1995, 1996) to a maximum of 8 in 2004. The number of loggerhead annual takes has ranged from zero to 3 (1992), the number of Kemp's ridley annual takes has been from zero to 8 (2004), and the number of green sea turtles collected annually on the intakes ranged from zero to 2 (2000).

As previously noted, the frequency and effectiveness of monitoring the intake trash bars prior to the first turtle impingement in 1992 is uncertain, and this may have played a role in the pattern of sea turtle impingements. However, the operation of the OCNGS has not changed appreciably since 1969, suggesting that the onset of turtle captures in 1992 is due to higher numbers of sea turtles in the action area. There are several possible explanations of an increased number of sea turtles in the action area, however, a likely cause is the deepening of Barnegat Inlet and associated waterway channels was completed immediately prior to 1992, when incidental captures of sea turtles began to occur at OCNGS. As the deepening of this inlet provided for a greater volume of water and tidal range in the Barnegat Bay and in the vicinity of Oyster Creek, a greater number of turtles may have been able to enter the Bay as a result of this deepening. If maintenance dredging of the Intracoastal waterway and Barnegat Inlet, which increases water volume, makes the Bay more accessible to turtles, the frequency of impingements at OCNGS may increase after each dredging episode and decrease as the Bay fills with sediment. While difficult to quantify, an increase in the occurrence of oceanic fronts may have also contributed to an increase in turtles in Barnegat Bay, as Polovina et al. (2000) suggest that turtles use oceanic fronts as migratory and foraging habitat. If a greater number of turtles are in the offshore New Jersey waters as a result of the oceanic patterns and they migrate through the Barnegat Inlet, more sea turtles may be found in the action area. Sea turtles may enter the Barnegat Bay with an increase in waves, winds and tidal prism. The yearly fluctuations may also be attributable to

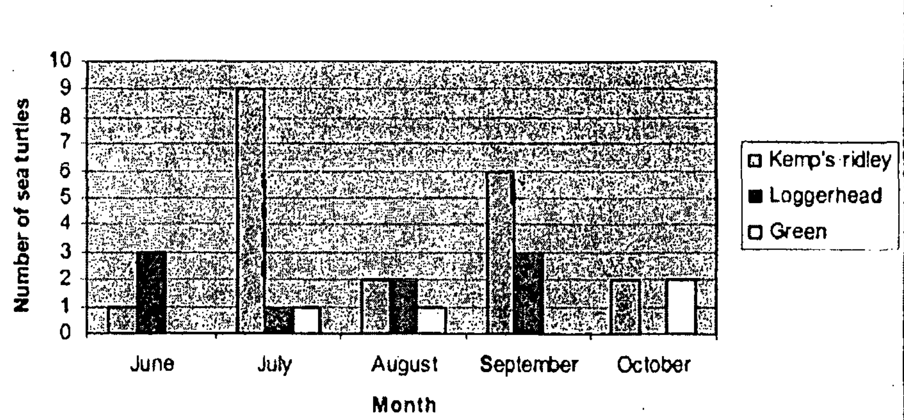
biological factors such as the abundance of prey organisms (e.g., blue crabs, horseshoe crabs) in the vicinity of Oyster Creek.

While four turtles were collected at OCNGS in 1994, and five turtles were captured in 2000, 2004 represents the largest number of takes (8) at OCNGS in any year. Physical and biological factors may have played a role attracting more turtles to the vicinity of OCNGS in 2004, but there is no information on the documentation of more turtles in the action area or the physical or biological parameters that may have caused such an increase during this time period. Additionally, there have been no operational changes at OCNGS that would account for the increase in turtle takes observed during 2004.

As mentioned in the BA, oceanic water temperatures were slightly higher during 2004 than in previous years. The NRC states that based on information provided from the National Weather Service, the average ocean water temperatures during the summer of 2004 were 1.4°C above normal. This increase in water temperature may have been a factor attracting juvenile sea turtles to the waters of the mid-Atlantic searching for foraging and developmental habitats. Therefore, the increased water temperatures observed in Atlantic waters during the summer of 2004 may be a factor contributing to the high number of Kemp's ridley sea turtles taken at OCNGS that year.

Only 2 juvenile Kemp's ridley sea turtles, one alive and one dead, have been taken at the OCNGS thus far during the summer of 2005 (as of September 1, 2005). When this level of take is compared to the 5 sea turtle takes observed prior to September 1, 2004, it may indicate that the high level of take observed during the summer of 2004 may not occur each year, although the higher level observed in 2004 could occur again if similar conditions occur.

FIGURE 1. Seasonal Occurrence and Species of Sea Turtles found at OCNGS intakes



All of the turtles have been collected at OCNGS from June through late October. This is consistent with the presumption that loggerhead, Kemp's ridley, and green sea turtles only occur in the action area during this time period and that the impacts of the OCNGS on listed species will only be observed during June through early November. Most of the turtles have been collected in July followed by September (Figure 1). It does not appear that there is any pattern in the species caught in the different months. At least two different species were caught in any given month, and in the months of July and August all three species were caught.

More Kemp's ridleys are caught at OCNGS than loggerheads and greens, which is noteworthy, as there are thought to be more loggerheads than Kemp's ridleys in New Jersey waters. Kemp's ridleys may be more likely to become impinged in the intake structures due to their physiology and behavioral characteristics. Swimming efficiency is likely related to the size of a turtle, with larger turtles having a stronger swimming ability than smaller turtles. As such, it is possible that because the Kemp's ridleys and greens found impinged at OCNGS are generally smaller than the loggerheads, they were not able to effectively escape the intake velocity. However, little information exists about the swimming behavior of turtles which can be used to make predictions about behavior at intake gratings or the ability to swim against various current velocities. Of the 33 turtles found at OCNGS from 1992 to 2004, 20 of these turtles were found alive, and 13 were dead. Of the eight loggerheads taken, 75% (n=6) were alive at the time of the take. Of the 21 Kemp's ridleys taken, 52% (n=11) were alive. Three of the four green turtles, 75% were alive at the time of the take. These sea turtles were all transported to the Marine Mammal Stranding Center and released back into the wild if possible.

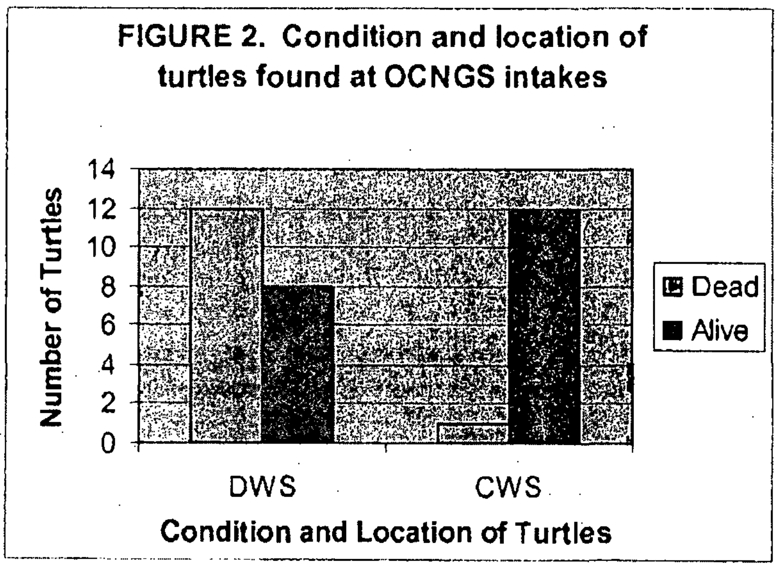
The ability of a given turtle to swim against the current at either the CWS or DWS intake and the condition at time of capture could depend on the species, size, relative health of each individual, or the particular conditions associated with each take (e.g., water temperature, duration of submergence time, etc.). Kemp's ridleys cannot survive underwater as long as other sea turtle species, as they have been found to drown faster in trawl nets compared to other species (Magnuson et al. 1990). A turtle weakened by disease or injured by a boat strike would be more susceptible to impingement if the velocity at the intake is a factor in the likelihood of impingement. Many of the sea turtles found impinged on the intake trash bars at OCNGS have previously been victims of collision with propellers. In several cases the wounds appear to be fresh, which may be a contributing factor to the impingement, as the sea turtle would be weak.

The loggerhead turtles incidentally captured at OCNGS had an average straight carapace length (SCL) of 47.9 cm. Through the 2004 season, the incidentally captured 21 Kemp's ridleys and 4 green turtles had an average SCL of 27.2 cm and 29.8 cm, respectively. However, during the summer of 2004, the average SCL for the 8 Kemp's ridleys taken was only 23.8 cm, with the smallest observed Kemp's ridley thus far at OCNGS, with an SCL of only 18.3. The small size of the turtles found in the intakes during 2004 may indicate that an increased number of small juveniles were present in the waters of the western north Atlantic than in previous years, possibly due to an increase in population size or changes in oceanic water temperatures. As discussed above, smaller sea turtles are subject to a greater amount of stress if caught in an intake, as they have a lower swimming ability.

Most of the sea turtles likely to occur in the action area are too large to pass through the intake trash bars, which are constructed with 6.6 cm wide openings. The BA states that any sea turtle that is smaller than the trash bar opening would pass through the CWS intake trash bars and be transported safely to the water via the same traveling screen system that returns entrained fish and other small organisms. It is unlikely that turtles small enough to fit through the 6.6 cm wide opening will be in the vicinity of the OCNGS, because turtles that young would not likely occur in inshore embayments, but rather in offshore currents.

There is currently no available data on the distribution of loggerheads, Kemp's ridleys and greens in the action area. It is possible that sea turtles occur in the vicinity of Oyster Creek and do not become impinged in the intake structure.

The cause of death for many of the turtles found at OCNGS is difficult to determine. The cause of death for the loggerhead captured on June 25, 1992, was determined to be from boat propeller wounds, before impingement at the OCNGS. The Kemp's ridley captured on October 17, 1993, was found to have drowned at the DWS trash bars, given the lack of obvious trauma. This turtle was found to have no stomach contents, which is not surprising as turtles are expected to be migrating during this time of year. The necropsy performed on the loggerhead captured on July 6, 1994, concluded that the turtle did not die at the OCNGS due to the level of decomposition, apparent bacterial infection, and good condition of the lungs. However, the presence of blue crabs in both the esophagus and stomach suggest that this turtle was actively feeding prior to death. While necropsies have not been performed on the additional four dead Kemp's ridleys, the specimens appeared to be fresh dead, leading to speculation that the impingement at the OCNGS was responsible, at least in part, for the mortalities. The one dead green turtle was also captured in fresh condition, also suggesting that drowning was the cause of death. However, it is possible that the documented lethal take at OCNGS could be an overestimate of the number of turtles that were actually killed by the facility.



The specific intake location could be a factor in the number of turtles incidentally captured as well as the condition of the turtle. Of the 33 incidental captures from 1992 to 2004, 20 (61%) have occurred at the DWS intake and 13 (39%) at the CWS intake (Figure 2). It is also noteworthy that more sea turtles have been found dead than alive at the DWS (60%), with 12 out of the 20 turtles found dead at that structure. Only 8% of the turtles found at CWS were dead, 1 out of the 13 turtles were found dead at that structure. This may be attributable to a number of variables. More Kemp's ridleys and greens have been found at the DWS than loggerheads, as these species have been found to have an overall smaller average carapace length than the loggerheads, they may be more susceptible to drowning due to their smaller size and lower swimming ability, especially when stressed. Additionally, the intake velocity at the DWS is higher than the CWS intake velocity, drawing in more water, which could contribute to a higher degree of mortality, for any size turtle.

During normal operation at 100% power, the two dilution water pumps typically withdraw a total of 1968 m^3/min from the intake canal and the four circulating water pumps withdraw a total of an additional 1740 m^3/min. The cross sectional area of the DWS intake is smaller than that of the CWS intake, resulting in a higher average through-screen velocity at the DWS than at the CWS intake. The DWS pumps typically withdraw about 53% of the water pumped from the intake canal, while the CWS pumps withdraw approximately 47%. The ratio of water intake levels are similar to the ratio of turtle takes between the DWS and CWS.

The floating debris/ice barrier upstream of the intake structures was designed to divert floating debris away from the CWS intake and toward the DWS intake. A turtle that swims or drifts on the surface toward the OCNGS intakes may be turned towards the DWS by the floating wooden debris/ice barrier. The orientation of the barrier may result in turtles at the surface being funneled toward the DWS. However, there are gaps on either end which a turtle could easily swim through and the barrier only extends 2 feet below the surface, so a healthy turtle could easily swim under the barrier and turn left towards the CWS intake.

The intake velocity, amount of water withdrawal, and the floating debris/ice barrier are potential factors in the higher number of takes at the DWS as compared to the CWS. The differences between DWS and CWS could also be attributable to the turtle species. From 1992 to 2004, five of the eight loggerheads (63%) captured at OCNGS have been retrieved from the CWS intake, while only 6 of the 21 Kemp's ridleys (28) have been found at the CWS intake. The loggerheads incidentally captured have been generally larger than the Kemp's ridleys, and the larger size of the loggerheads could result in more efficient swimming ability, allowing the animal to move around the floating ice/debris barrier and end up at the CWS intake. If Kemp's ridley and green turtles were found close to the surface and lacking the swimming ability or strength to dive beneath the floating ice/debris barrier, they would be channeled to the DWS intake. These species' prey are typically found on the bottom (e.g., crustaceans, marine grasses), which would suggest that they would not be on the surface if they were foraging.

While a record number of Kemp's ridley sea turtles were taken during the 2004 season, only three of these eight turtles were dead when recovered at the intake. The three Kemp's ridleys which were found to be dead during the 2004 season were captured on July 4, July 20, and September 11 respectively. Each of the three turtles were found amongst trash and debris of the trash bars. The turtle found on July 20th was found in the CWS structure and the other two turtles were recovered from the DWS structure. It was not possible to determine definitively whether any of these turtles had died prior to arriving at OCNGS or as a result of impingement on the intake structures. The other 5 Kemp's ridleys captured in 2004 were all recovered alive and transported to the MMSC at Brigantine, NJ for examination and release.

B and C) Impacts of thermal discharge: Cold Stunning and Effects on Prey
Heated condenser cooling water discharged from the CWS and ambient temperature intake canal water discharged from the DWS meet and mix in the discharge canal and are returned to Barnegat Bay via this canal. This process results in heated discharge water mixing with the ambient water and elevating the normal water temperatures. Sea turtles may be affected directly or indirectly by these elevated temperatures, but it is important to note that no sea turtles have been observed in the vicinity of the OCNGS discharge.

The impacts of the thermal plume in Barnegat Bay appear to be on the surface and relatively small, thus reducing the potential for negative affects to sea turtles. The cooling water discharged from OCNGS has been studied on several occasions to determine the distribution, geometry, and dynamic behavior of the thermal plume (OCNGS 2000). While the discharge temperature near OCNGS is high, the turbulent dilution mixing produces rapid temperature reductions. Little mixing with the heated discharge and ambient water occurs in Oyster Creek from the site of the discharge to the Bay, because of the relatively short residence time and the lack of turbulence or additional dilution. However, in Barnegat Bay, temperatures are rapidly reduced when mixing with ambient temperature Bay water occurs as well as heat rejection into the atmosphere. In Barnegat Bay, the plume occupies a relatively large surface area (estimated to be less than 1.6 km in an east-west direction by 5.6 km in a north-south direction, under all conditions) and in general, elevated temperatures do not extend to the bottom of the Bay except in the area immediately adjacent to the mouth of Oyster Creek. While the plume in Barnegat Bay is on the surface, it may impact sea turtles as they are coming up for air.

The water flowing from the DWS and CWS is discharged through separate structures. However, sea turtle entrainment in the DWS and CWS discharge structures is unlikely. The discharge velocities are high (65-95 cm/sec), likely precluding a sea turtle from staying in the vicinity of the discharge for a significant amount of time. Turtles that stay in this area would most likely have to undergo continuous swimming activity, and the food resources in this area would also have to be sufficient to maintain such activity. During the winter, it is unlikely that the prey will be sufficient to maintain this level of activity, but data are not available on the amount of prey in the discharge area in the winter.

The more notable impacts on sea turtles from the DWS and CWS discharges are likely due to the elevated temperatures of the discharges. The temperature rise of the CWS discharge is typically about 11°C above ambient canal temperatures, while the DWS discharge is approximately 5.6°C

above ambient water temperatures when two dilution pumps are operating. While sea turtles will not likely be killed by the elevated temperatures, temperature increases may affect normal distribution and foraging patterns. The thermal effluent discharged from the plant into Oyster Creek may represent an attraction for turtles. If turtles are attracted into Oyster Creek by this thermal plume, they could remain there late enough in the fall to become cold-stunned when they finally travel into Barnegat Bay at the start of their southern migration. 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 concentrated around the heated discharge or in surrounding waters heated by the discharge (e.g., Oyster Creek or Barnegat Bay) and move outside of this plume into cooler waters (approximately less than 8-10°C), they could become cold stunned.

Existing data from OCNGS and other 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. Data reported by the STSSN indicate that cold-stunning has occurred around mid-November in New York waters. No incidental captures of sea turtles have been reported at the OCNGS later than October, suggesting that sea turtles leave this site before cold-stunning could potentially occur.

Cold shock mortalities of fish have occurred at OCNGS when water temperatures have decreased in the fall. The number and severity of these events have been reduced as a result of the operation of the two dilution pumps in the fall, when ambient water temperatures began to drop, to decrease the attractiveness of the discharge canal as overwintering habitat. As mentioned, cold stunning of sea turtles has not been documented at OCNGS, but the measures to reduce cold shock mortalities of fish would also help reduce the potential for cold stunning of sea turtles.

While cold stunning could still occur given the heated discharge and the water temperatures in New Jersey during certain times of the year (e.g., less than 10°C), NRC has identified certain aspects of the OCNGS discharge that may make cold stunning less likely to occur. For example, the area where sea turtles could overwinter (and encounter acceptable water temperatures) is limited to the small area around the condenser discharge, prior to any mixing with the DWS flow. Winter water temperatures in the discharge canal, downstream of the area where the DWS and CWS flows mix, routinely fall below 7.2°C. These temperatures in the discharge canal would not be suitable for sea turtle survival. Sea turtles generally are found in water temperatures greater than 10°C, but have occasionally been documented in colder waters. For example, in March 1999, a live loggerhead sea turtle was observed taken on a monkfish gillnet haul in North Carolina, in a water temperature of 8.6°C. In any event, during the winter, the area where the water temperatures would be suitable for sea turtles is small and localized.

The thermal discharges from OCNGS may influence the distribution and survival of sea turtles' primary prey resources. Blue crab and horseshoe crab are found in the canal, generally during the warmer months, but the effect of the heated effluent on the distribution of these species is uncertain. Crustaceans may move elsewhere when conditions are unfavorable (e.g., elevated water temperatures), but there is no information at this time suggesting that this has occurred at

OCNGS. It is probable that when sea turtles are foraging in the summer, the heated effluent will not have as great of an impact on the turtles as it would in the winter. Furthermore, the New Jersey Department of Environmental Protection evaluated the impact of the OCNGS thermal plume on Barnegat Bay and concluded that the effects on fish distribution and abundance were small and localized (Summers et al. 1989 in OCNGS 2000). Thus, it appears that the preferred prey of loggerhead, Kemp's ridleys, and greens are impacted insignificantly, if at all, by the thermal discharge from OCNGS.

D) Impacts of chlorine used at the OCNGS

Low level, intermittent chlorination is used to control biofouling in the OCNGS service water system and circulating water systems. The main condenser cooling water is chlorinated for approximately two hours per day. The permitted maximum daily concentration of chlorine discharge is 0.2 mg/l or a maximum daily chlorine usage of 41.7 kg/day, as limited by the New Jersey Pollutant Discharge Elimination System permit for the OCNGS. The NRC has stated that the chlorine demand in the main condenser discharge consumes almost all remaining free chlorine and results in very little chlorine being released to the discharge canal (approximately 0.1 mg/l). The DWS does not have any chlorine discharges.

Chemical contaminants have been found in the tissues of sea turtles from certain geographical areas. While the effects of chemical contaminants on turtles are relatively unclear, they may have an effect on sea turtle reproduction and survival. There is no information available on the effects of chlorination on sea turtles. It is also unknown as to whether the sea turtles impinged at OCNGS had appreciable levels of chlorine in their issues. The necropsies conducted on the sea turtles found at the OCNGS did not assess the levels of contaminants in the tissue.

The chlorine discharge may have some level of impact on sea turtles, but the effect is unquantifiable at this time. In any event, there is only a small quantity of chlorine applied to the CWS, the residual chlorine levels in the condenser discharge are near zero, and the condenser discharge is combined with unchlorinated DWS flow before entering the discharge canal. Any level of chlorine in the water would be further diluted as the discharge canal mixes with Barnegat Bay, the area where sea turtles would most likely be present. This minimal level of chlorination in the discharge canal and its proximity to the greatest number of sea turtles in the action area probably has insignificant effects on sea turtles.

<u>Sea Turtles in the Action Area</u>

There is limited information on the abundance and distribution of sea turtles in the action area. While sea turtles could enter inshore New Jersey waters through the Beach Haven Inlet, several hundred kilometers south of OCNGS, it is improbable that turtles in this area would migrate northward through the narrow intracoastal waterway to the Barnegat Bay. Thus, the Barnegat Inlet, approximately 300 m wide, is considered to be the only direct access for turtles to Barnegat Bay, a shallow, lagoon-type estuary. In 1988 a project was initiated by the Army Corps of Engineers to realign the inlets south jetty thus creating an inlet where the south jetty was parallel to the north jetty. The jetty project was completed in 1991 resulting in a much freer interchange of water between the ocean and the bay. Between 1991 and 1993 the inlet was dredged to create a deep channel allowing for less restricted tidal flow. The newly designed and dredged inlet

resulted in a significantly greater volume of water passing through Barnegat Inlet during any given tidal cycle. After a sea turtle enters Barnegat Bay, they must then pass through the wooden support structures of three bridges in order to reach the OCNGS. While this route may seem difficult for migrating or foraging sea turtles, the presence of sea turtles on the CWS and DWS intake structures provides evidence that sea turtles do occur in the action area.

No turtles have been sighted during many years of biological sampling efforts in Barnegat Bay conducted by or for the OCNGS. These biological monitoring programs were intended to qualify and quantify the marine biota of Barnegat Bay, and were not specifically tailored to capture sea turtles. In any event, sampling occurred during all twelve months of the year, day and night, at the plant intake structures as well as the intake and discharge canals. Approximately 20,000 hours of impingement and entrainment sampling (24-54 hours/week) were conducted at the CWS intake from 1975-1985, and no turtles were observed. Additionally, in Barnegat Bay, Forked River, and Oyster Creek, otter trawl sampling was conducted, gillnet sampling (with mesh sizes of 38, 70, and 89 mm) was conducted at the surface to mid-depth, and stretch mesh (0.6 and 1.3 cm) seines sampled the entire water column in nearshore areas. From 1975-1985, nearly 3000 trawl samples, hundreds of gillnet samples, and more than 2000 seine samples were collected, but no sea turtles were captured.

<u>Summary of effects</u>

The greatest risk to sea turtles from the continued operation of the OCNGS is due to impingement at the DWS and CWS intakes, resulting in injury or mortality. Sea turtles that are impinged at the intakes may drown if they have been previously injured, are diseased or incapacitated, or if they are not removed from the intakes promptly before they drown. The amount of time sea turtles are capable of remaining underwater varies on a number of parameters, including the species of sea turtle, size and condition of the animal, and water temperature. In any event, sea turtles, both alive and dead, may become impinged at the OCNGS intakes. Turtles may also be affected by the heated discharge or chlorine levels in the water, but to an insignificant extent, if at all.

Loggerhead sea turtles

Like other sea turtles, loggerheads demonstrate slow growth, delayed maturity, and extended longevity to allow individuals to produce more offspring. As discussed in the Status of the Species section, more offspring may compensate for the high natural mortality in the early life stages; i.e., mortality rates of eggs and hatchling are generally high and decrease with age and growth. The risks of delayed maturity are that annual survival of the later life stages must be high in order for the population to grow. Population growth has been found to be highly sensitive to changes in annual survival of the juvenile and adult stages. Crouse (1999) reports, "not only have large juveniles already survived many mortality factors and have a high reproductive value, but there are more large juveniles than adults in the population. Therefore, relatively small changes in the annual survival rate impact a large segment of the population, magnifying the effect."

The loggerhead sea turtles in the action area are likely to represent differing proportions of the four western Atlantic subpopulations. Although the northern breeding population produces

about 9 percent of the total loggerhead nests, they comprise more of the loggerhead sea turtles found in foraging areas from the northeastern U.S. to Georgia. Twenty-five to 59 percent of the loggerhead sea turtles in this area are from the northern breeding population (Sears 1994, Norrgard 1995, Sears et al. 1995, Rankin-Baransky 1997, Bass et al. 1998). As described in the Status of the Species section, the TEWG (2000) estimated that there was a mean of 6,247 northern subpopulation nests in 1989 to 1998, translating into approximately 3,800 nesting females. This subpopulation may be experiencing a significant decline due to a combination of natural and anthropogenic factors, demographic variation, and a loss of genetic viability. It is likely that a large number of the loggerheads which may occur in the action area may originate from the northern breeding population. Loggerheads originating from the southern breeding population could also be in the vicinity of the OCNGS.

A total of 8 loggerhead impingements occurred at the OCNGS intake trash bars between January 1992 and December 2004, with an average of approximately 1 impingement per year. The maximum number of loggerheads taken annually was 3; however, one of these takes was a recapture. Two loggerheads were captured in 2 separate years, 2000 and 1992. The maximum number of loggerhead mortalities in one year was 1. Necropsy reports are not available for all the loggerhead mortalities, so it is not possible to adjust this rate to reflect mortalities which may have occurred prior to impingement. Given the level of previous impingement at the OCNGS, the status and distribution of loggerhead sea turtles, and the proposed operation of the facility with the mitigation measures in place, the anticipated loggerhead take associated with the continued operation of the OCNGS is 2 animals per year, with a maximum of one lethal. This level of take has been altered from the incidental take statement issued with the Opinion dated July 18, 2001. This previous Opinion exempted the incidental take of 5 loggerhead turtles, 2 lethal. After reviewing the level and frequency of loggerhead takes since 1992, the incidental take level was altered to better reflect the likelihood of future loggerhead takes at OCNGS> The take level was set at a level that represents the greatest number of loggerhead takes in one year.

NMFS anticipates that no more than 2 loggerheads (no more than 1 lethal) will be taken each year as a result of the continued operation of the OCNGS. The death of one loggerhead every year would represent a loss of less than 0.05 percent of the estimated number of nesting females in the northern subpopulation. These are conservative estimates, however, since the loss of loggerhead turtles during the proposed activity are not likely limited to adult females, the only segment of the population, or subpopulation, for which NMFS has any population estimates.

Given the low numbers of anticipated annual take and the current loggerhead population sizes, the lethal take of up to 4 turtles, one per year over the next 4 years, is not expected to have a detectable effect on the numbers, reproduction, and distribution of loggerhead sea turtles. As such, the continued operation of the OCNGS and the lethal take of 4 loggerhead turtles over the next 4 years is not expected to appreciably reduce the likelihood of survival and recovery of the species.

Kemp's ridley sea turtles
A total of 21 Kemp's ridley impingements occurred at the OCNGS intake trash bars between January 1992 and December 2004. An average of approximately 1 impingement per year was

observed up until the year 2004 when 8 Kemp's ridley were impinged by OCNGS. Three of the eight Kemp's ridley turtles taken in 2004 were dead. It was not possible to determine definitively whether any of these turtles had died prior to arriving at OCNGS or as a result of interactions with the intake structures. The other 5 Kemp's ridleys captured in 2004 were all recovered alive and transported to the MMSC at Brigantine, NJ for examination and release. Given the level of previous impingement at the OCNGS, the status and distribution of Kemp's ridley sea turtles, and the continued operation of the facility with the mitigation measures in place, the anticipated Kemp's ridley take associated with the continued operation of the OCNGS is eight animals per year, with a maximum of four lethal. This take level represents the largest occurrence of impinged Kemp's ridleys at the facility in one year, therefore, it is possible that this level of impingement may occur in the future, thus, the incidental take level will be increased to 8 Kemp's per year. The lethal take exemption has been increased from 3 to 4 Kemp's ridley turtles. Between 1992 and 2004 10 of the 21 impingements were lethal, correlating to approximately 50% of the Kemp's taken. Therefore, the lethal take has been increased to 4, as that would represent 50% of the total 8 Kemp's ridleys exempted per year.

The biology of the Kemp's ridley also suggests that losses of juvenile turtles can have a magnified effect on the survival of this species. NMFS anticipates that no more than 8 Kemp's ridleys (no more than 4 lethal) will be taken each year as a result of the continued operation of the OCNGS. The death of 4 Kemp's ridleys every year would represent a loss of less than 0.1 percent of the population. As with loggerheads, these are conservative estimates since the loss of Kemp's ridleys during the proposed activity is not likely limited to adult females, the only segment of the population for which NMFS has any population estimates.

Given the low numbers of anticipated take, the current population size, and the current information suggesting that Kemp's ridleys are increasing in numbers, the lethal take of up to 16 Kemp's ridley turtles, 4 per year over the next 4 years, is not likely to have a detectable effect on the numbers, reproduction, and distribution of Kemp's ridley turtles. As such, the continued operation of the OCNGS and the lethal take of 16 Kemp's ridley turtles over the next 4 years is not expected to appreciably reduce the likelihood of survival and recovery of the species.

Green sea turtles

A total of 4 green turtle impingements occurred at the OCNGS intake trash bars between January 1992 and December 2004. These four takes have occurred since 1999. The maximum number of green turtles taken annually is one, and the maximum number of green turtle mortalities in any given year is one. Given the level of previous impingement at the OCNGS, the status and distribution of green sea turtles, and the proposed operation of the facility with the mitigation measures in place, the anticipated green turtle take associated with the continued operation of the OCNGS is one animal per year, this animal may be either a lethal or non-lethal take. All four of the green turtle takes occurred between 1999 and 2003, indicating that the incidental take of a green sea turtle at the OCNGS may continue to occur in future years.

Population estimates for the western Atlantic green sea turtles are not available. However, nesting beach data corrected on index beaches since 1989 have shown a general positive trend. NMFS anticipates that one green (lethal or non-lethal) will be taken each year as a result of the

continued operation of the OCNGS. At this time, the effects of the lethal incidental take of one green sea turtle a year on the population is not likely to represent a significant loss to the population.

Given the low numbers of anticipated annual take, the lethal take of up to 4 turtles, one per year over the next 4 years, is not expected to have a detectable effect on the numbers, reproduction, and distribution of green sea turtles. As such, the continued operation of the OCNGS and the lethal take of 4 green turtles over the next 4 years is not expected to appreciably reduce the likelihood of survival and recovery of the species.

Summary
Based on the above rationale, NMFS anticipates that two (2) loggerheads (one (1) lethal), eight (8) Kemp's ridleys (four (4) lethal), or one (1) green (one (1) lethal), will be taken each year as a result of the operation of the OCNGS. To ensure that the analysis of effects in this biological opinion captures the long-term effects of this recurring activity, NMFS assumes that the operation of the OCNGS will occur over the next four years from 2005 through 2009. Given the anticipated annual take, 16 Kemp's ridley, 4 green and 4 loggerhead turtles are anticipated to be lethally taken at the OCNGS before the current NRC license expires in April 2009. The low numbers of takes is not likely to appreciably reduce the likelihood of survival and recovery of loggerhead, green, or Kemp's ridley sea turtles.

CUMULATIVE EFFECTS
Cumulative effects include the effects of future state, tribal, local or private actions that are reasonably certain to occur within the action area considered in this biological opinion. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Natural mortality of sea turtles, including disease (parasites), predation, and cold-stunning, occurs in mid-Atlantic waters. In addition to impingement in the OCNGS intakes, sources of human-induced effects on turtles in the action area include incidental takes in state-regulated fishing activities, vessel collisions, ingestion of plastic debris, and pollution. While the combination of these unrelated, non-federal activities in Barnegat Bay may adversely affect populations of endangered and threatened sea turtles.

NMFS believes that the fishing activities in Barnegat Bay will continue in the future, and as a result, sea turtles will continue to be impacted by fishing gear used in the action area. Throughout their range, sea turtles have been taken in different types of gear, including gillnet, pound net, rod and reel, trawl, pot and trap, longline, and dredge gear. Thus, it is likely that commercial and recreational fisheries in the action area will continue to impact sea turtles, albeit to an unknown extent.

Commercial and recreational vessels colliding with sea turtles will also continue in the future, and sea turtles will continue to be injured or killed from these interactions. Fifty to 500 loggerheads and 5 to 50 Kemp's ridley turtles are estimated to be killed by vessel traffic per year in the U.S. (National Research Council 1990). Although some of these strikes may be post-

mortem, the data show that vessel traffic is a substantial cause of sea turtle mortality. As turtles will likely be in the area where high vessel traffic occurs, the potential for collisions with vessels transiting these waters exists. The Marine Mammal Stranding Center in Brigantine, New Jersey, reports an increase in the number of turtles hit by boats in New Jersey inshore and nearshore waters, as determined from sea turtle stranding records.

Twenty-eight percent of the land around Barnegat Bay is developed. In the future, a larger amount of the watershed will likely be developed because Barnegat Bay supports a thriving tourist industry and more individuals are moving to the coast in general. An increase in boating, fishing, and general use of the Bay is also likely to occur. With this increase in development and utilization of the Bay, there is a greater potential for debris and pollutants to enter the waters of the action area. Sea turtles will continue to be impacted by pollution in the Bay and any increase in debris or pollutants would exacerbate this effect. Marine debris (e.g., discarded fishing line or lines from boats) can entangle turtles in the water and drown them. Turtles commonly ingest plastic or mistake debris for food. Storm water runoff and other sources of nonpoint source pollution may result in the waters containing chemical contaminants. The Barnegat Bay estuary may be more susceptible to toxic chemical contaminants than may other estuaries because of its limited dilution capacity and flushing rate (Barnegat Bay Estuary Program 2001). Chemical contaminants may have an effect on sea turtle reproduction and survival, but the impacts are still relatively unclear.

INTEGRATION AND SYNTHESIS OF EFFECTS

Sea turtles are known to use New Jersey's coastal waters. While loggerhead, Kemp's ridley and green sea turtles are known to occur in the action area, there has not been a recent study determining the distribution or abundance of turtles in Barnegat Bay, and the use of the action area by sea turtles has likely changed over the past 30 years, largely due to the deepening of Barnegat Inlet. This theory can be substantiated by the level of documented impingements occurring at the OCNGS intake structures. From 1969 to 1992, there were no sea turtles observed captured at OCNGS. Incidental captures of sea turtles at OCNGS CWS and DWS cooling water intakes were documented in June of 1992 by OCNGS Environmental Controls personnel and reported to NMFS according to reporting procedures established through informal consultation conducted between OCNGS, NRC, and NMFS. There have been 33 total observed takes at the OCNGS since 1969, including 21 Kemp's ridleys, 8 loggerheads (which includes 1 recapture), and 4 greens. The number of sea turtles collected at the OCNGS CWS and DWS intakes per year has ranged from zero (from 1969 to 1991, 1995, 1996) to a maximum of 8 in 2004. The number of loggerhead annual takes has ranged from zero to three (1992), the number of Kemp's ridley annual takes has been from zero to 8 (2004), and the number of green sea turtles collected annually on the intakes ranged from zero to one (1999, 2000, 2001, 2003).

The operation of the OCNGS is likely to result in the lethal and non-lethal take of loggerhead, Kemp's ridley and green sea turtles. The monitoring measures and consistent use of resuscitation techniques employed by the OCNGS will ensure that these turtle takes are observed and reported, and the diligent implementation of these procedures and prompt discovery of impinged turtles may likely serve to capture more sea turtles alive than dead.

In the past, the maximum number of sea turtles taken annually was 8 (in 2004), and the maximum number of turtle mortalities in any given year was 3 (in 1994 and 2004). Of the 33 turtles found impinged at OCNGS, 20 of these turtles were alive at the time they were found by the staff of OCNGS in the intake structures. A large percentage of loggerhead and green turtles were found alive, 6 of the 8 loggerheads (75%), 3 of the 4 greens (75%). Only approximately half of the Kemp's ridleys were found alive, 11 of the 21 turtles.

The thermal discharge may also directly and indirectly impact sea turtles by altering their normal distribution and attracting turtles to the heated discharge (potentially resulting in a cold stun event), or modifying the distribution and abundance of prey resources in the action area. However, based on the structure and size of thermal discharge from OCNGS, it is unlikely that this will affect sea turtles at OCNGS. The use of chlorine to control biofouling may also affect turtles, albeit to an unknown extent, if chlorine is found in the discharge, however, this has been determined to be unlikely to affect sea turtles at OCNGS.

An unknown number of loggerhead, Kemp's ridley, and green sea turtles may be injured or killed by commercial or recreational fisheries, vessel collisions, ingestion of debris, or chemical contamination in the action area prior to the expiration of the current NRC permit. Adverse effects to sea turtle habitat are also expected to continue. Since quantitative data on the extent of these impacts to turtle populations are lacking, a reliable cumulative assessment of these effects is not possible.

Based on information provided in the Effects of the Action section of this Opinion, NMFS anticipates that no more than 2 loggerheads (1 lethal), 8 Kemp's ridleys (4 lethal), or 1 green (1 lethal), will be taken each year as a result of the operation of the OCNGS. In light of the current status and known trends for loggerhead, Kemp's ridley, and green sea turtles, as well as potential effects caused by human activities and previously described in the Environmental Baseline of this Opinion, the level of take described above is not likely to reduce appreciably the likelihood of both the survival and recovery of loggerhead, Kemp's ridley, and green sea turtle populations, respectively.

CONCLUSION

After reviewing the current status of the species discussed herein, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, it is NMFS' biological opinion that the proposed action may adversely affect but is not likely to jeopardize the continued existence of endangered Kemp's ridley, green, or threatened loggerhead sea turtles. No critical habitat has been designated in the action area, therefore, none will be affected.

INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by NMFS to include any act which

actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns including breeding, spawning, rearing, migrating, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by NRC so that they become binding conditions for the exemption in section 7(o)(2) to apply. NRC has a continuing duty to regulate the activity covered by this Incidental Take Statement. If NRC (1) fails to assume and implement the terms and conditions or (2) fails to adhere to the terms and conditions of the Incidental Take Statement through enforceable terms, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, NRC must report the progress of the action and its impact on the species to the NMFS as specified in the Incidental Take Statement [50 CFR §402.14(i)(3)].

The current NRC license for OCNGS is will expire in April 2009. If NRC proposes to issue a new license, the NRC is required to reinitiate consultation with NMFS regarding the overall operation of OCNGS and its affects on endangered and threatened species under the proposed new license. The incidental take allowance summarize above is authorized through April 2009, or until such time as a new license is issued.

Amount or extent of take anticipated
NMFS anticipates that the continued operation of the OCNGS may result in the injury or mortality of loggerhead, Kemp's ridley, or green sea turtles. Based on previous levels of impingement, the distribution of sea turtle species, and the operation of the facility, NMFS anticipates that no more than two (2) loggerheads (one (1) lethal), eight (8) Kemp's ridleys (four (4) lethal), and one (1) green (one (1) lethal), will be taken each year as a result of the operation of the OCNGS.

Effect of the take
In the accompanying biological opinion, NMFS determined that levels of anticipated take are not likely to result in jeopardy to loggerhead, Kemp's ridley, or green sea turtles.

Reasonable and Prudent Measures
NMFS believes the following reasonable and prudent measures are necessary and appropriate to minimize impacts of incidental take of endangered and threatened sea turtles:

1. OCNGS must implement a NMFS approved program in place to prevent, monitor, minimize, and mitigate the incidental take of sea turtles in the CWS and DWS intake structures.

2. All sea turtle impingements associated with the OCNGS and sea turtle sightings in the action area must be reported to NMFS.

Terms and Conditions

In order to be exempt from prohibitions of section 9 of the ESA, NRC must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

1. The Oyster Creek Nuclear Generating Station's CWS and DWS (when operational) intake trash bars must be cleaned daily from June 1 to October 31.

   a. Cleaning must include the full length of the trash rack, i.e., down to the bottom of each intake bay. To lessen the possibility of injury to a turtle, the raking process must be closely monitored so that it can be stopped immediately if a turtle is sighted.

   b. Personnel must be instructed to look beneath surface debris before the rake is used to lessen the possibility of injury to a turtle.

   c. Personnel cleaning the racks must inspect all trash that is dumped, particularly at night. Turtles or turtle parts might be confused with horseshoe crabs caught on the racks in abundance.

   d. An alternative method of daily cleaning of the trash racks must be developed for use between June 1 through October 31 when the trash rake is unavailable due to necessary repair or maintenance.

2. Inspection of CWS and DWS cooling water intake trash bars (and immediate area upstream) must continue to be conducted at least once every 4 hours (twice per 8-hour shift) from June 1 through October 31. Inspections must follow a set schedule so that they are regularly spaced rather than clumped. The proposed schedule of 1-2 hours into each 8-hour shift and 5-6 hours into each 8-hour shift must be followed. Times of inspections, including those when no turtles were sighted, must be recorded.

3. Lighting must be maintained at the intake bays to enable inspection personnel to see the surface of each intake bay and to facilitate safe handling of turtles which are discovered at night. Portable spotlights must be available at both the CWS and the DWS for times when extra lighting is needed.

4. Dip nets, baskets, and other equipment must be available at both the CWS and the DWS and must be used to remove smaller sea turtles from the OCNGS intake structures to reduce trauma caused by the existing cleaning mechanism. Each intake structure must have equipment suitable for rescuing large turtles as well (e.g., rescue sling or other provision).

making this a priority for nmfsc.

taking tissue samples @ plant?

5. If any live or dead sea turtles are taken at OCNGS, plant personnel must notify NMFS within 24 hours of the take (Pat Scida, Endangered Species Coordinator at 978-281-9208). An incident report for sea turtle take (Appendix III) must also be completed by plant personnel and sent to the Endangered Species Coordinator via FAX (978-281-9394) within 24 hours of the take. Every sea turtle must be photographed. Information in Appendix IV will assist in identification of species impinged. All sea turtles that are sighted within the vicinity of OCNGS (including the intake and discharge structures) must also be recorded, and this information must be submitted in the annual report.

6. An attempt to resuscitate comatose sea turtles must be made according to the procedures described in Appendix II. These procedures must be posted in appropriate areas such as the intake bay areas for both the CWS and the DWS, any other area where turtles would be moved for resuscitation, and the CWS and DWS operator's office(s).

7. A stranding/rehabilitation facility with the appropriate ESA authority must be contacted immediately following any live sea turtle take. Appropriate transport methods must be employed following the stranding facilities protocols, to transport the animal to the care of the stranding/rehabilitation personnel for evaluation, necessary veterinary care, tagging, and release in an appropriate location and habitat.

8. All dead sea turtles that are in adequate condition (i.e., relatively fresh dead) must be necropsied by qualified personnel. The OCNGS must coordinate with a qualified facility or individual to perform the necropsies on sea turtles impinged at OCNGS, prior to the incidental turtle take, so that there is no delay in performing the necropsy or obtaining the results. The necropsy results must identify, when possible, the sex of the turtle, stomach contents, and the estimated cause of death. Necropsy reports must be submitted to the NMFS Northeast Region with the annual review of incident reports or, if not yet available, within 1 year of the incidental take. and NRC, NJDEP. 60 days

9. OCNGS personnel must observe the canal area for sea turtles where and when possible (i.e., during the daylight hours). Any sea turtles sighted in the canal and in vicinity of OCNGS (not necessarily only near the intake structures) must be reported to NMFS within 24 hours of the observation (Pat Scida, Endangered Species Coordinator at (978) 281-9208 or FAX (978) 281-9394).

10. An annual report of incidental takes must be submitted to NMFS by January 1 of each year. This report will be used to identify trends and further conservation measures necessary to minimize incidental takes of sea turtles. The report must include, as detailed above, all necropsy reports, incidental take reports, photographs (if not previously submitted), a record of all sightings in the vicinity of OCNGS, and a record of when inspections of the intake trash bars were conducted for the 24 hours prior to the take. The annual report must also include any potential measures to reduce sea turtle impingement or mortality at the intake structures.

11. The plant personnel or NRC must notify NMFS when the OCNGS reaches 50% of the incidental take level for any species of sea turtle. At that time, NRC and NMFS will determine if additional measures are needed to minimize impingement at the CWS or DWS intake structures.

NMFS anticipates that no more than 2 loggerheads (no more than 1 lethal), 8 Kemp's ridleys (no more than 4 lethal), or no more than 1 green (lethal or non-lethal), will be taken each year as a result of the operation of the OCNGS. The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the potential for and impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, the level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. When the incidental take has been exceeded, the NRC must immediately provide an explanation of the causes of the taking and review with the NMFS the need for possible modification of the reasonable and prudent measures.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. NMFS has determined that the continued operation of the OCNGS as proposed is not likely to jeopardize the continued existence of endangered and threatened sea turtles located in the project area. To further reduce the adverse effects of the dredging project on listed species, NMFS recommends that NRC implement the following conservation measures.

1. The NRC and OCNGS should investigate methods to increase lighting and visibility at all trash racks, and implement these methods. At present, with use of portable spotlights and current lighting visibility is limited to approximately 1 meter below the water surface.

2. In conjunction with NMFS, the NRC should support and develop a research program to determine whether the plant provides features attractive to sea turtles (e.g., concentration of prey around intake structures, heated discharge). This program should investigate habitat use, diet, and local and long-term movements of sea turtles. Use of existing mark/recapture and telemetry methods should be considered in Barnegat Bay and associated waterways.

3. The NRC and OCNGS personnel should support and conduct underwater and surface videography or diving behavior telemetry studies of turtles at the intake bays, in the Forked River, in the Oyster Creek discharge canal, and in Barnegat Bay to determine how turtles use these waterways and their behavior in the intake bays. The surface videography can help identify sea turtles in Forked River prior to impingent in the intake structures.

4. The NRC and OCNGS personnel should support and conduct investigations on the variable environmental conditions which may contribute to or result in increased sea turtle taking (e.g. temperature changes, wind direction, influx of prey). Increased monitoring during favorable conditions for sea turtle presence near OCNGS should result from the investigations.

5. The NRC and OCNGS personnel should support and conduct in-water assessments, abundance, and distribution surveys for sea turtles in Barnegat Bay, Forked River, and Oyster Creek. Information obtained from these surveys should include the number of turtles sighted, species, location, habitat use, time of year, and portions of the water column sampled.

6. Historical benthic survey data should be reviewed and updated to identify sea turtle prey density and distribution at various sites in the action area and associated waterways. This information would clarify the potential for sea turtle prey to be attracted to the intake structures or area around OCNGS during times when turtles are likely to be in the action area.

NRC should communicate with NMFS on an annual basis to review incidental takes of sea turtles at OCNGS, assess the status of sea turtles in the project area and associated waterways, and to reconsider the Reasonable and Prudent Measures and Terms and Conditions of this Opinion as appropriate.

REINITIATION OF CONSULTATION

This concludes formal consultation on the operation of the OCNGS. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of taking specified in the incidental take statement is exceeded; (2) 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; (3) the identified action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in this biological opinion; or (4) a new species is listed or critical habitat designated that may be affected by the identified action. In instances where the amount or extent of incidental take is exceeded, the NRC must immediately request reinitiation of formal section 7 consultation.

As mention previously, consultation must be initiated on any proposed new NRC license for OCNGS. The current license is set to expire in 2009.

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APPENDIX I.

Incidental Take of Sea Turtles at Oyster Creek Nuclear Generating Station Intake Structures

January 1992 through August 2005

SEA TURTLE IMPINGEMENT							
Date/Time	*Species*	*Status*	*Length**	Weight	*Location*	*Temp*	*Details*
6/25/1992 1250 hrs	Cc	Dead	35.5 cm SCL	9.6 kg	Impinged on DWS trash bars, upon routine inspection	21.6 C	Several deep gashes on side, appeared to be boat propeller wounds. MMSC necropsy concluded cause of death from propeller wounds, before impingement.
9/9/1992 1800 hrs	Cc	Alive	46.7 cm SCL	19.1 kg	Impinged on CWS trash bars, found upon routine inspection	25.6 C	Small wound with scar tissue behind head. Released into discharge canal.
9/11/1992 1400 hrs	Cc	Alive	46.7 cm SCL	19.1 kg	Impinged on CWS trash bars, found upon routine inspection	26.2 C	Small wound with scar tissue behind head. Considered to be the same turtle found on 9/9/92. Taken to MMSC, tagged, and released into ocean near Brigantine, NJ.
10/26/1992 0300 hrs	Lk	Alive	32.0 cm SCL	5.7 kg	Impinged on CWS trash bars, found upon routine inspection. Head out of water pointing upward.	11.3 C	Turtle found alive, moving about normally. Two scars from slash-like wounds on plastron. Not sure how long present at intake structure, but may have been there between 3 and 8 hours. Turtle taken to MMSC in Brigantine, NJ, then to North Carolina, with eventual release into the ocean off NC on October 31, 1992.
10/17/1993 1200 hrs	Lk	Dead	26.0 cm SCL	3.0 kg	Impinged on DWS trash bars, found upon routine inspection	16.7 C	Turtle found limp, immobile, no apparent breathing and resuscitation efforts were unsuccessful. Minor scrape marks on plastron may have occurred during removal from intake area. Not sure how long present at intake structure, but may have been there between 4 and 8 hours. Necropsy by Dr. Morreale found that drowning likely cause of death (fresh dead, no obvious trauma, empty stomach).
6/19/1994 1330 hrs	Cc	Alive	36.8 cm SCL	9.8 kg	Found in CWS Bay #4, swimming freely upstream of the trash bars	27.3 C	Turtle found alive, moving about normally. Within 3-4 hours of capture, turtle taken to MMSC in Brigantine, NJ, tagged, and released offshore.
7/1/1994 1000 hrs	Lk	Dead	27.7 cm SCL	3.6 kg	Found in DWS Bay #5 upon routine cleaning	25.7 C	Turtle found limp, immobile, no apparent breathing, strong odor of decomposition, and resuscitation efforts were unsuccessful. Not sure how long present at intake structure, but intake bay was cleaned the previous afternoon. Turtle sent to Cornell for necropsy but the results have not been received to date.

7/6/1994 0640 hrs	Cc	Dead	61.4 cm SCL	40.4 kg	Found in DWS Bay #4 upon routine cleaning of dilution intakes	26.9 C	Turtle found limp, immobile, no apparent breathing and resuscitation efforts were unsuccessful. Three old deep scars or slash-like propeller wounds on turtle, decomposition of all 4 appendages, large notch along turtle's marginal scutes. Not sure how long present at intake structure, but trash bars were cleaned 6 to 8 hours earlier. Necropsy by MMSC (R. Schoelkopf) found that turtle likely died 1 to 2 days before arriving at OCNGS, probably due to a long term illness.
7/12/1994 2240 hrs	Lk	Dead	26.7 cm SCL	3.3 kg	Found in DWS Bay #4 upon routine cleaning of dilution intakes	28.4 C	Turtle found limp, immobile, no apparent breathing and resuscitation efforts were unsuccessful. Not sure how long present at intake structure, but may have been there for several hours. Turtle sent to Cornell for necropsy but the results have not been received to date.
9/4/1997 0318 hrs	Lk	Dead	48.8 cm SCL	18.1 kg	Found in DWS Bay #6 upon routine cleaning of dilution intakes	22.9 C	Turtle found limp, immobile, no apparent breathing and resuscitation efforts were unsuccessful. Two dorsal scutes had damage, but no prominent scars of slashlike wounds. Not sure how long present at intake structure, but may have been there for up to several hours.
8/18/1998 0959 hrs	Cc	Alive	50.8 cm SCL	22.4 kg	Found live while routinely inspecting CWS Bay #4, swimming freely upstream of the trash bars	26.9 C	Turtle found alive, moving about normally. A 12 foot 1/4" polypropylene rope with a bucket attached to one end was wrapped around the right front flipper, and the flipper was atrophied and partially decayed. OCNGS was in full power operation with four circulating water pumps and 2 dilution pumps. Turtle taken to MMSC in Brigantine, NJ, then to Sea World in Orlando, FL, with eventual release into the ocean.
9/23/1999 0310 hrs	Lk	Alive	26.4 cm SCL	2.9 kg	Impinged on CWS trash bars, found upon routine inspection	19.6 C	Turtle found alive, moving about normally and with no apparent injury. OCNGS was in full power operation with four circulating water pumps and 2 dilution pumps. Turtle taken to MMSC in Brigantine, NJ, then to Virginia State Aquarium, with eventual release into the ocean.
10/23/1999 0200 hrs	Cm	Dead	27.0 cm SCL	2.8 kg	Found in DWS Bay #4 upon routine cleaning of dilution intakes	17.1 C	Turtle found limp, immobile, no apparent breathing and resuscitation efforts were unsuccessful. OCNGS was in full power operation with four circulating water pumps and 2 dilution pumps. Dilution trash racks were mechanically cleaned the previous day. Turtle sent to Cornell for necropsy, but results have not been received to date.
06/23/2000 0120 hrs	Cc	Alive	47.8cm SCL	17.2 kg	Found in front of trash bars in DWS Bay #1 intake	25.3 C	Live turtle very active and no visible wounds or injury. OCNGS was in full power operation with four circulating water pumps and 2 dilution pumps. Transferred to MMSC in Brigantine NJ, with eventual release into the ocean.

7/2/2000 1500 hrs	Lk	Dead	27.3 cm SCL	3.2 kg	Found floating into the trash bars in DWS Bay #1 intake on routine inspection of dilution trash racks	25.6 C	Turtle found limp, immobile, no apparent breathing and resuscitation efforts were unsuccessful. Two dorsal scutes had superficial scrape marks. OCNGS was in full power operation with four circulating water pumps and 2 dilution pumps. Dilution trash racks were mechanically cleaned the previous evening (2130 hrs). Turtle in freezer until necropsy can be completed.
8/3/2000 1525 hrs	Cm	Alive	29.2 cm SCL	3.4 kg	Found live in DWS Bay #4 intake upon routine inspection of dilution trash racks	28.8 C	Turtle found alive, moving about normally and with no apparent injury. Carapace covered in barnacles; several marginal scutes had dull grayish coloration (indicative of possible fungal infection). OCNGS was in full power operation with four circulating water pumps and 2 dilution pumps. Dilution trash racks mechanically cleaned earlier the same day. Turtle taken to MMSC in Brigantine, NJ, then to the Topsail Island Rehab Center, NC, with eventual release into the ocean on October 12, 2000.
8/28/2000 0112 hrs	Lk	Alive	26.2 cm SCL	2.9 kg	Found live in DWS Bay #1 intake upon routine inspection of dilution trash racks	26.5 C	Turtle found alive, moving about normally and with no apparent injury. OCNGS was in 72% power operation with four circulating water pumps and 2 dilution pumps. Dilution trash racks cleaned previous day and inspected earlier same night of capture. Turtle taken to MMSC in Brigantine, NJ, then to the Topsail Island Rehab Center, NC, with anticipated eventual release into the ocean.
9/18/2000 1310 hrs	Cc	Alive	57.2 cm SCL	26.5 kg	Found live while routinely inspecting CWS intake trash rack Bay #4	20.4 C	Turtle found alive, moving normally with no apparent injury. Majority of dorsal surface covered in barnacles; few scutes partially peeled. OCNGS was in full power operation with four circulating water pumps and 2 dilution pumps. Trash racks cleaned previous afternoon. Turtle taken to MMSC in Brigantine, NJ, and released into the ocean off Nags Head, NC in late September.
7/8/2001 1430 hrs	Cm (juv)	Alive	26.7 cm SCL	2.3 kg	Found live while routinely inspecting CWS Bay #4	26.7 C	Turtle found alive, swimming freely in Bay #4, moving normally with no apparent injury. Dorsal surface had several barnacles. OCNGS was in full power operations with four circulating water pumps and 2 dilution pumps. Trash racks cleaned the previous afternoon. Turtle taken to Marine Mammal Stranding Center in Brigantine, NJ. After confirming health and tagged, turtle released into nearshore waters near Brigantine.
7/22/2001 1744 hrs	Lk (juv)	Dead	26 cm SCL	2.9 kg	Impinged on DWS Bay #5 trash bars, found upon routine inspection	26.9 C	Turtle found with deep slice wound between head and carapace on left side of neck. OCNGS was in full power operation with four circulating water pumps and 2 dilution pumps. Trash racks cleaned at 330 hrs same day. Turtle in freezer until necropsy could be set up.

8/14/2001 0334 hrs	Lk	Dead	22.8 cm SCL; 21.4 cm SCW		Impinged on DWS Bay #6	27.8 C	Turtle appears fresh dead, no obvious prop wounds. Several scutes scraped on carapace centerline and posterior notch. Intake velocity was 73 cm/sec and OCNGS had 982 percent power generating capacity over previous 48 hrs. Trash racks cleaned at 245 hrs same day. Intake canal turbidity high.
6/29/2002 0200	Lk	Alive	25.4 cm SCL; 24.1 cm SCW	n/a	Found alive, swimming in CWS Bay #5 and #6 cooling water intake, upon routine inspection of trash racks. Removed with large dipnet.	26.2 C	Turtle alive and active, appears healthy. Fresh scar (?) on right side of carapace. OCNGS had 99.9% power. CWS trash racks cleaned ~4 hrs earlier (2200 6/28/02). Animal delivered to MMSC at 0455 hrs - wound determined to not be of significant concern (eating and appeared healthy). Turtle later died at MMSC, and necropsy performed: Found to be female, all tissues surrounding cracked area were necrotic.
7/3/2002 0755	Lk	Alive	34 cm SCL; 32.5 cm SCW	6 kg	Found alive, swimming in front of DWS Bay #5 intake trash bars, upon routine inspection. Removed with dipnet.	28.2 C	Turtle alive and active, appears healthy. One small scrape <1 cm long on dorsal scute. OCNGS had 100% power. Screen last inspected 7-3-02 0500 hrs. Animal delivered to MMSC at 1015 hrs; was swimming and eating well. Tagged (monellear #SSL127) and released on July 9 near Brigantine, NJ.
9/24/2003 1455	Lk	Alive	31.1 cm SCL; 30.5 cm SCW	11.5 lbs	Found alive, in intake pipe at DWS Bay #6.	73 F	Turtle alive and active, appears healthy. One lateral scute chipped (old); 2 scrapes on ventral surface. OCNGS had 100% power. Screen last inspected 9-23-03 1345 hrs. Animal picked up by MMSC at 1745 hrs; healthy and active. Tagged and released on 9-25 near Brigantine, NJ.
10/24/2003 0850	Cm (juv)	Alive	36.2 cm SCL; 30.5 cm SCW	6.9 kg	Found alive, against CWS Intake Bay #4.	53 F (11.7 C)	Turtle alive and alert, appears healthy but a bit lethargic. One scraped dorsal scute and one chipped lateral scute. Heavy algal growth on carapace. OCNGS had 98% power. Screen last inspected 10-24-03 0500 hrs. Animal picked up by MMSC at 1030 hrs; healthy and active. Held at MMSC and then transferred to VMSM for rehab and eventual release.
7/4/2004 1215 hrs	Lk	Dead	26.5 cm SCL; 25 cm SCW	5.4 kg	Found dead upon routine cleaning at DWS Bay #4 trash racks	25.6 C (78 F)	Turtle fresh dead, no obvious prop wounds or other injuries. Minor scrape/bruising on plastron near centerline. OCNGS had 100% percent power generating capacity over previous 48 hrs. Trash racks cleaned at 0800 hrs same day. Delivered to MMSC for necropsy at 1500 hrs: female; all internal organs healthy/unremarkable; stomach of crab parts; lungs appeared normal but sank in salt water solution and felt compressed. Probable cause of death--suffocation.
7/11/2004 1422 hrs	Lk	Alive	23 cm SCL; 22 cm SCW	1.8 kg	Upon routine cleaning, found swimming upstream of DWS Bay #5 trash racks. Turtle surfaced and dove, and personnel retrieved the animal	81.5 F (27.5 C)	Turtle appeared in good condition. Some minor scrapes noted on ventral surface of carapace (plastron?). OCNGS had 100% power. Screen last inspected 7-11-04 at 1315 hrs. Animal taken to MMSC at 1623 hrs. Examined and released 2 days later off Brigantine, NJ.

7/16/2004 1100 hrs	Lk	Alive	28 cm SCL	3.1 kg	Found alive upon routine cleaning of DWS Bay #5 trash racks	76 F (22.4 C)	Turtle appeared in good condition. Some small scrapes noted on plastron. OCNGS had 100% power. Screen last inspected 7-16-04 at 0900 hrs. Animal taken to MMSC at 1300 hrs. Examined and released off Brigantine, NJ.
7/20/2004 1213 hrs	Lk	Dead	18.3 cm SCL	0.8 kg	Found dead upon routine cleaning of CWS Bay #1 trash racks	79.7 F (26.5 C)	Resuscitation attempted but unsuccessful. Small puncture wound 1.3 cm diameter in left rear surface of carapace. OCNGS had 100% power. Screen last inspected 7-19-04 at 2115 hrs. Taken to MMSC at 1000 on 7-21-04 for necropsy.
8/7/2004 0900 hrs	Lk	Alive	27 cm SCL	3.2 kg	Found alive upon routine cleaning of DWS Bay #5 trash racks	72.8 F (22.7 C)	Turtle appeared healthy and moving normally. Small bruise noted on plastron and healed scar from previous injury on left side of head in front of eye. OCNGS had 100% power. Screen last inspected 8-7-04 at 0515 hrs. Animal taken to MMSC on 8-7-04. Examined and subsequently released into ocean off Brigantine, NJ. **EXCEEDED ITS**
9/11/2004 1010 hrs	Lk	Dead	22.3 cm SCL; 22.9 cm SCW	2.2 kg	Found dead upon routine cleaning of DWS Bay #5 trash racks	24.3 C	Bruising to plastron and undersides of all 4 flippers. Small puncture wound to base of neck. Healed prop cut to rear of carapace. Animal taken to MMSC, then to U of Penn for necropsy. **EXCEEDED ITS**
9/12/2004 2329 hrs	Lk	Alive	21 cm SCL; 19.5 cm CW	1.4 kg	Found alive upon routine cleaning of CWS #5 trash racks	24.9 C	Active and eating on its own. Bruising to plastron and undersides of all 4 flippers. Missing left front flipper (clean amputation). Small bump on beak area of head. Turtle was taken to the MMSC in Brigantine, NJ, where it was examined, measured, fed and held for observation prior to release. The turtle was transported to the VMSM for tagging and release. **EXCEEDED ITS**
9/23/2004 2145 hrs	Lk	Alive	24.2 cm SCL	1.9 kg	Found alive swimming in CWS Bay #3 cooling water intake, upon routine inspection of trash racks.	21.9 C	Turtle appeared alert and responsive. Turtle was taken to the MMSC in Brigantine, NJ, where it was examined, measured, fed and held for observation prior to release. The turtle was transported to the VMSM for tagging and release. **EXCEEDED ITS**
7/4/2005 0905 hrs	**Lk**	**Dead**	**23.2 cm SCL**	**1.4 kg**	**Found in DWS Bay #1 upon routine cleaning of dilution intakes**	**21.9 C**	**Turtle was found dead. Turtle was taken to the MMSC in Brigantine, NJ, where it was examined, measured, the necropsy was preformed.**
8/5/2005 0500 hrs	**Lk**	**Alive**	**23.6 cm SCL**	**1.9 kg**	**Found alive swimming in CWS Bay #4 cooling water intake, upon routine inspection of trash racks. Wound on front left flipper.**	**28.2 C**	**Turtle appeared alert and responsive, wound observed on front left flipper. Turtle was taken to the MMSC in Brigantine, NJ, where it was examined, measured, fed and held for observation. The turtle was then sent to the Sea Turtle Rescue and Rehabilitiation Center in Topsail, NC for further rehab. On August 12, the turtle was trasported to the NC State Veterinary School for amputation of the wounded flipper. The turtle will undergo further rehab before being released.**

APPENDIX I.

Incidental Take of Sea Turtles at Oyster Creek Nuclear Generating Station Intake Structures
January 1992 through August 2005

SEA TURTLE IMPINGEMENT

Date/Time	*Species*	*Status*	*Length**	Weight	*Location*	*Temp*	*Details*
6/25/1992 1250 hrs	Cc	Dead	35.5 cm SCL	9.6 kg	Impinged on DWS trash bars, upon routine inspection	21.6 C	Several deep gashes on side, appeared to be boat propeller wounds. MMSC necropsy concluded cause of death from propeller wounds, before impingement.
9/9/1992 1800 hrs	Cc	Alive	46.7 cm SCL	19.1 kg	Impinged on CWS trash bars, found upon routine inspection	25.6 C	Small wound with scar tissue behind head. Released into discharge canal.
9/11/1992 1400 hrs	Cc	Alive	46.7 cm SCL	19.1 kg	Impinged on CWS trash bars, found upon routine inspection	26.2 C	Small wound with scar tissue behind head. Considered to be the same turtle found on 9/9/92. Taken to MMSC, tagged, and released into ocean near Brigantine, NJ.
10/26/1992 0300 hrs	Lk	Alive	32.0 cm SCL	5.7 kg	Impinged on CWS trash bars, found upon routine inspection. Head out of water pointing upward.	11.3 C	Turtle found alive, moving about normally. Two scars from slash-like wounds on plastron. Not sure how long present at intake structure, but may have been there between 3 and 8 hours. Turtle taken to MMSC in Brigantine, NJ, then to North Carolina, with eventual release into the ocean off NC on October 31, 1992.
10/17/1993 1200 hrs	Lk	Dead	26.0 cm SCL	3.0 kg	Impinged on DWS trash bars, found upon routine inspection	16.7 C	Turtle found limp, immobile, no apparent breathing and resuscitation efforts were unsuccessful. Minor scrape marks on plastron may have occurred during removal from intake area. Not sure how long present at intake structure, but may have been there between 4 and 8 hours. Necropsy by Dr. Morreale found that drowning likely cause of death (fresh dead, no obvious trauma, empty stomach).
6/19/1994 1330 hrs	Cc	Alive	36.8 cm SCL	9.8 kg	Found in CWS Bay #4, swimming freely upstream of the trash bars	27.3 C	Turtle found alive, moving about normally. Within 3-4 hours of capture, turtle taken to MMSC in Brigantine, NJ, tagged, and released offshore.
7/1/1994 1000 hrs	Lk	Dead	27.7 cm SCL	3.6 kg	Found in DWS Bay #5 upon routine cleaning	25.7 C	Turtle found limp, immobile, no apparent breathing, strong odor of decomposition, and resuscitation efforts were unsuccessful. Not sure how long present at intake structure, but intake bay was cleaned the previous afternoon. Turtle sent to Cornell for necropsy but the results have not been received to date.

7/6/1994 0640 hrs	Cc	Dead	61.4 cm SCL	40.4 kg	Found in DWS Bay #4 upon routine cleaning of dilution intakes	26.9 C	Turtle found limp, immobile, no apparent breathing and resuscitation efforts were unsuccessful. Three old deep scars or slash-like propeller wounds on turtle, decomposition of all 4 appendages, large notch along turtle's marginal scutes. Not sure how long present at intake structure, but trash bars were cleaned 6 to 8 hours earlier. Necropsy by MMSC (R. Schoelkopf) found that turtle likely died 1 to 2 days before arriving at OCNGS, probably due to a long term illness.
7/12/1994 2240 hrs	Lk	Dead	26.7 cm SCL	3.3 kg	Found in DWS Bay #4 upon routine cleaning of dilution intakes	28.4 C	Turtle found limp, immobile, no apparent breathing and resuscitation efforts were unsuccessful. Not sure how long present at intake structure, but may have been there for several hours. Turtle sent to Cornell for necropsy but the results have not been received to date.
9/4/1997 0318 hrs	Lk	Dead	48.8 cm SCL	18.1 kg	Found in DWS Bay #6 upon routine cleaning of dilution intakes	22.9 C	Turtle found limp, immobile, no apparent breathing and resuscitation efforts were unsuccessful. Two dorsal scutes had damage, but no prominent scars of slashlike wounds. Not sure how long present at intake structure, but may have been there for up to several hours.
8/18/1998 0959 hrs	Cc	Alive	50.8 cm SCL	22.4 kg	Found live while routinely inspecting CWS Bay #4, swimming freely upstream of the trash bars	26.9 C	Turtle found alive, moving about normally. A 12 foot 1/4" polypropylene rope with a bucket attached to one end was wrapped around the right front flipper, and the flipper was atrophied and partially decayed. OCNGS was in full power operation with four circulating water pumps and 2 dilution pumps. Turtle taken to MMSC in Brigantine, NJ, then to Sea World in Orlando, FL, with eventual release into the ocean.
9/23/1999 0310 hrs	Lk	Alive	26.4 cm SCL	2.9 kg	Impinged on CWS trash bars, found upon routine inspection	19.6 C	Turtle found alive, moving about normally and with no apparent injury. OCNGS was in full power operation with four circulating water pumps and 2 dilution pumps. Turtle taken to MMSC in Brigantine, NJ, then to Virginia State Aquarium, with eventual release into the ocean.
10/23/1999 0200 hrs	Cm	Dead	27.0 cm SCL	2.8 kg	Found in DWS Bay #4 upon routine cleaning of dilution intakes	17.1 C	Turtle found limp, immobile, no apparent breathing and resuscitation efforts were unsuccessful. OCNGS was in full power operation with four circulating water pumps and 2 dilution pumps. Dilution trash racks were mechanically cleaned the previous day. Turtle sent to Cornell for necropsy, but results have not been received to date.
06/23/2000 0120 hrs	Cc	Alive	47.8cm SCL	17.2 kg	Found in front of trash bars in DWS Bay #1 intake	25.3 C	Live turtle very active and no visible wounds or injury. OCNGS was in full power operation with four circulating water pumps and 2 dilution pumps. Transferred to MMSC in Brigantine NJ, with eventual release into the ocean.

7/2/2000 1500 hrs	Lk	Dead	27.3 cm SCL	3.2 kg	Found floating into the trash bars in DWS Bay #1 intake on routine inspection of dilution trash racks	25.6 C	Turtle found limp, immobile, no apparent breathing and resuscitation efforts were unsuccessful. Two dorsal scutes had superficial scrape marks. OCNGS was in full power operation with four circulating water pumps and 2 dilution pumps. Dilution trash racks were mechanically cleaned the previous evening (2130 hrs). Turtle in freezer until necropsy can be completed.
8/3/2000 1525 hrs	Cm	Alive	29.2 cm SCL	3.4 kg	Found live in DWS Bay #4 intake upon routine inspection of dilution trash racks	28.8 C	Turtle found alive, moving about normally and with no apparent injury. Carapace covered in barnacles; several marginal scutes had dull grayish coloration (indicative of possible fungal infection). OCNGS was in full power operation with four circulating water pumps and 2 dilution pumps. Dilution trash racks mechanically cleaned earlier the same day. Turtle taken to MMSC in Brigantine, NJ, then to the Topsail Island Rehab Center, NC, with eventual release into the ocean on October 12, 2000.
8/28/2000 0112 hrs	Lk	Alive	26.2 cm SCL	2.9 kg	Found live in DWS Bay #1 intake upon routine inspection of dilution trash racks	26.5 C	Turtle found alive, moving about normally and with no apparent injury. OCNGS was in 72% power operation with four circulating water pumps and 2 dilution pumps. Dilution trash racks cleaned previous day and inspected earlier same night of capture. Turtle taken to MMSC in Brigantine, NJ, then to the Topsail Island Rehab Center, NC, with anticipated eventual release into the ocean.
9/18/2000 1310 hrs	Cc	Alive	57.2 cm SCL	26.5 kg	Found live while routinely inspecting CWS intake trash rack Bay #4	20.4 C	Turtle found alive, moving normally with no apparent injury. Majority of dorsal surface covered in barnacles; few scutes partially peeled. OCNGS was in full power operation with four circulating water pumps and 2 dilution pumps. Trash racks cleaned previous afternoon. Turtle taken to MMSC in Brigantine, NJ, and released into the ocean off Nags Head, NC in late September.
7/8/2001 1430 hrs	Cm (juv)	Alive	26.7 cm SCL	2.3 kg	Found live while routinely inspecting CWS Bay #4	26.7 C	Turtle found alive, swimming freely in Bay #4, moving normally with no apparent injury. Dorsal surface had several barnacles. OCNGS was in full power operations with four circulating water pumps and 2 dilution pumps. Trash racks cleaned the previous afternoon. Turtle taken to Marine Mammal Stranding Center in Brigantine, NJ. After confirming health and tagged, turtle released into nearshore waters near Brigantine.
7/22/2001 1744 hrs	Lk (juv)	Dead	26 cm SCL	2.9 kg	Impinged on DWS Bay #5 trash bars, found upon routine inspection	26.9 C	Turtle found with deep slice wound between head and carapace on left side of neck. OCNGS was in full power operation with four circulating water pumps and 2 dilution pumps. Trash racks cleaned at 330 hrs same day. Turtle in freezer until necropsy could be set up.

8/14/2001 0334 hrs	Lk	Dead	22.8 cm SCL; 21.4 cm SCW		Impinged on DWS Bay #6	27.8 C	Turtle appears fresh dead, no obvious prop wounds. Several scutes scraped on carapace centerline and posterior notch. Intake velocity was 73 cm/sec and OCNGS had 982 percent power generating capacity over previous 48 hrs. Trash racks cleaned at 245 hrs same day. Intake canal turbidity high.
6/29/2002 0200	Lk	Alive	25.4 cm SCL; 24.1 cm SCW	n/a	Found alive, swimming in CWS Bay #5 and #6 cooling water intake, upon routine inspection of trash racks. Removed with large dipnet.	26.2 C	Turtle alive and active, appears healthy. Fresh scar (?) on right side of carapace. OCNGS had 99.9% power. CWS trash racks cleaned ~4 hrs earlier (2200 6/28/02). Animal delivered to MMSC at 0455 hrs - wound determined to not be of significant concern (eating and appeared healthy). Turtle later died at MMSC, and necropsy performed. Found to be female, all tissues surrounding cracked area were necrotic.
7/3/2002 0755	Lk	Alive	34 cm SCL; 32.5 cm SCW	6 kg	Found alive, swimming in front of DWS Bay #5 intake trash bars, upon routine inspection. Removed with dipnet.	28.2 C	Turtle alive and active, appears healthy. One small scrape <1 cm long on dorsal scute. OCNGS had 100% power. Screen last inspected 7-3-02 0500 hrs. Animal delivered to MMSC at 1015 hrs; was swimming and eating well. Tagged (monellear #SSL127) and released on July 9 near Brigantine, NJ.
9/24/2003 1455	Lk	Alive	31.1 cm SCL; 30.5 cm SCW	11.5 lbs	Found alive, in intake pipe at DWS Bay #6.	73 F	Turtle alive and active, appears healthy. One lateral scute chipped (old); 2 scrapes on ventral surface. OCNGS had 100% power. Screen last inspected 9-23-03 1345 hrs. Animal picked up by MMSC at 1745 hrs; healthy and active. Tagged and released on 9-25 near Brigantine, NJ.
10/24/2003 0850	Cm (juv)	Alive	36.2 cm SCL; 30.5 cm SCW	6.9 kg	Found alive, against CWS Intake Bay #4.	53 F (11.7 C)	Turtle alive and alert, appears healthy but a bit lethargic. One scraped dorsal scute and one chipped lateral scute. Heavy algal growth on carapace. OCNGS had 98% power. Screen last inspected 10-24-03 0500 hrs. Animal picked up by MMSC at 1030 hrs; healthy and active. Held at MMSC and then transferred to VMSM for rehab and eventual release.
7/4/2004 1215 hrs	Lk	Dead	26.5 cm SCL; 25 cm SCW	5.4 kg	Found dead upon routine cleaning at DWS Bay #4 trash racks	25.6 C (78 F)	Turtle fresh dead, no obvious prop wounds or other injuries. Minor scrape/bruising on plastron near centerline. OCNGS had 100% percent power generating capacity over previous 48 hrs. Trash racks cleaned at 0800 hrs same day. Delivered to MMSC for necropsy at 1500 hrs: female; all internal organs healthy/unremarkable; stomach of crab parts; lungs appeared normal but sank in salt water solution and felt compressed. Probable cause of death--suffocation.
7/11/2004 1422 hrs	Lk	Alive	23 cm SCL; 22 cm SCW	1.8 kg	Upon routine cleaning, found swimming upstream of DWS Bay #5 trash racks. Turtle surfaced and dove, and personnel retrieved the animal	81.5 F (27.5 C)	Turtle appeared in good condition. Some minor scrapes noted on ventral surface of carapace (plastron?). OCNGS had 100% power. Screen last inspected 7-11-04 at 1315 hrs. Animal taken to MMSC at 1623 hrs. Examined and released 2 days later off Brigantine, NJ.

7/16/2004 1100 hrs	Lk	Alive	28 cm SCL	3.1 kg	Found alive upon routine cleaning of DWS Bay #5 trash racks	76 F (22.4 C)	Turtle appeared in good condition. Some small scrapes noted on plastron. OCNGS had 100% power. Screen last inspected 7-16-04 at 0900 hrs. Animal taken to MMSC at 1300 hrs. Examined and released off Brigantine, NJ.
7/20/2004 1213 hrs	Lk	Dead	18.3 cm SCL	0.8 kg	Found dead upon routine cleaning of CWS Bay #1 trash racks	79.7 F (26.5 C)	Resuscitation attempted but unsuccessful. Small puncture wound 1.3 cm diameter in left rear surface of carapace. OCNGS had 100% power. Screen last inspected 7-19-04 at 2115 hrs. Taken to MMSC at 1000 on 7-21-04 for necropsy.
8/7/2004 0900 hrs	Lk	Alive	27 cm SCL	3.2 kg	Found alive upon routine cleaning of DWS Bay #5 trash racks	72.8 F (22.7 C)	Turtle appeared healthy and moving normally. Small bruise noted on plastron and healed scar from previous injury on left side of head in front of eye. OCNGS had 100% power. Screen last inspected 8-7-04 at 0515 hrs. Animal taken to MMSC on 8-7-04. Examined and subsequently released into ocean off Brigantine, NJ. **EXCEEDED ITS**
9/11/2004 1010 hrs	Lk	Dead	22.3 cm SCL; 22.9 cm SCW	2.2 kg	Found dead upon routine cleaning of DWS Bay #5 trash racks	24.3 C	Bruising to plastron and undersides of all 4 flippers. Small puncture wound to base of neck. Healed prop cut to rear of carapace. Animal taken to MMSC, then to U of Penn for necropsy. **EXCEEDED ITS**
9/12/2004 2329 hrs	Lk	Alive	21 cm SCL; 19.5 cm CW	1.4 kg	Found alive upon routine cleaning of CWS #5 trash racks	24.9 C	Active and eating on its own. Bruising to plastron and undersides of all 4 flippers. Missing left front flipper (clean amputation). Small bump on beak area of head. Turtle was taken to the MMSC in Brigantine, NJ, where it was examined, measured, fed and held for observation prior to release. The turtle was transported to the VMSM for tagging and release. **EXCEEDED ITS**
9/23/2004 2145 hrs	Lk	Alive	24.2 cm SCL	1.9 kg	Found alive swimming in CWS Bay #3 cooling water intake, upon routine inspection of trash racks.	21.9 C	Turtle appeared alert and responsive. Turtle was taken to the MMSC in Brigantine, NJ, where it was examined, measured, fed and held for observation prior to release. The turtle was transported to the VMSM for tagging and release. **EXCEEDED ITS**
7/4/2005 0905 hrs	**Lk**	**Dead**	**23.2 cm SCL**	**1.4 kg**	**Found in DWS Bay #1 upon routine cleaning of dilution intakes**	**21.9 C**	**Turtle was found dead. Turtle was taken to the MMSC in Brigantine, NJ, where it was examined, measured, the necropsy was preformed.**
8/5/2005 0500 hrs	**Lk**	**Alive**	**23.6 cm SCL**	**1.9 kg**	**Found alive swimming in CWS Bay #4 cooling water intake, upon routine inspection of trash racks. Wound on front left flipper.**	**28.2 C**	**Turtle appeared alert and responsive, wound observed on front left flipper. Turtle was taken to the MMSC in Brigantine, NJ, where it was examined, measured, fed and held for observation. The turtle was then sent to the Sea Turtle Rescue and Rehabilitiation Center in Topsail, NC for further rehab. On August 12, the turtle was trasported to the NC State Veterinary School for amputation of the wounded flipper. The turtle will undergo further rehab before being released.**

NOAA Technical Memorandum NMFS-NE-161

Demersal Fish and American Lobster Diets in the Lower Hudson - Raritan Estuary

U. S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Region
Northeast Fisheries Science Center
Woods Hole, Massachusetts

November 2000

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NOAA Technical Memorandum NMFS-NE-161

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Demersal Fish and American Lobster Diets in the Lower Hudson - Raritan Estuary

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November 2000

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Acronyms

DO	=	*dissolved oxygen*
ES	=	*empty stomachs*
FL	=	*fork length*
FO	=	mean percent *frequency* of *occurrence*
IRI	=	*index* of *relative importance*
TDW	=	mean percent contribution to *total* stomach content *dry weight*
TL	=	*total length*
TN	=	mean percent contribution to *total number* of individual items in the stomach
TV	=	mean percent contribution to *total* stomach content *volume*
TW	=	mean percent contribution to *total* stomach content *weight*
YOY	=	*young of* the *year*

ABSTRACT

Characterizing the demersal fish food web in the Hudson-Raritan Estuary is important for understanding specifically how this estuary is used by fishery resources. Knowledge of fish food webs and essential fish forage resources of the estuary can support habitat management decisions. Little is known about diets of the community of fish and the American lobster (*Homarus americanus*) that inhabit this estuary, although it is a major estuarine complex in the Northeast that continues to support fisheries. To gain insight into trophic and habitat functions in this estuary, the diets of the most abundant demersal fish species and the American lobster were examined. These predators were collected by trawl in various parts of the Hudson-Raritan Estuary over six seasons, July 1996 through November 1997.

The most widely preyed-upon taxa were crustaceans, such as: small or juvenile decapods (*e.g.*, sevenspine bay or sand shrimp (*Crangon septemspinosa),* hermit crabs (*Pagurus* spp.), juvenile Atlantic rock crabs (*Cancer irroratus*), lady crabs (*Ovalipes ocellatus)*, and mud crabs (Xanthidae)); the mysid *Neomysis americana*; and several amphipod species. Clam siphons, primarily from the northern quahog (*Mercenaria mercenaria*) and Atlantic surfclam (*Spisula solidissima*), were commonly preyed upon by winter flounder (*Pseudopleuronectes americanus*), as well as by scup (*Stenotomus chrysops*) and spot (*Leiostomus xanthurus*) during some seasons. The diets of common fish and the American lobster in the human-stressed Hudson-Raritan Estuary are similar to those in other, less-stressed estuaries in the Middle Atlantic Bight.

INTRODUCTION

The Lower Hudson-Raritan Estuary (hereafter, the Estuary), located at the mouths of the Hudson, Raritan, and Navesink-Shrewsbury Rivers (New Jersey - New York), is the polyhaline part of a major, urban, estuarine complex in the Northeast. The Estuary has supported diverse and productive commercial and recreational fisheries (MacKenzie 1992). Many of these fisheries are gone or operate at a reduced level because of low resource abundances, harvest regulations, and/or habitat degradation.

The Estuary has been characterized as one of the most human-altered on the East Coast (Wolfe *et al.* 1996). Although some sources of habitat alteration or degradation in the Estuary (*e.g.*, point-source discharges and marsh filling) are being largely controlled through regulation, other sources (*e.g.*, nonpoint-source discharges and toxic substance spills) continue with little effective control, and new activities have the potential for adverse effects (Palermo *et al.* 1998). Despite these alterations, the Estuary is still used by a diversity of aquatic species (Wilk *et al.* 1998).

To conserve and restore the Estuary's fishery resources, there is a need for community- or ecosystem-level information on the status and function of the Estuary's various habitats and associated species to provide advice for policy decisions on conflicting uses of the Estuary. Characterizing fish and American lobster diets in the Estuary is critical for understanding the value and habitat sources of various prey taxa in the estuarine food web. Knowledge of food webs and key predator-prey relationships is important for habitat-use policy development (Hartman and Brandt 1995).

Although broadscale trophodynamic studies have been conducted in many other Middle Atlantic Bight estuaries, *e.g.*, Long Island Sound (Richards 1963), central New Jersey (Festa 1979), Delaware Bay (de Sylva *et al.* 1962), and Chesapeake Bay (Homer and Boynton 1978), as well as offshore in the New York Bight (*e.g.*, Sedberry 1983; Bowman *et al.* 1987), the Hudson-Raritan Estuary has never had such an effort. Only the middle Hudson River part of the Estuary (near Indian Point, New York) has received attention for general dietary analysis (Gladden *et al.* 1988), although there have been focused dietary analyses of a few species such as striped bass (*Morone saxatilus*) and juvenile bluefish (*Pomatomus saltatrix*). Also, Stehlik *et al.* (in preparation) examined the diets of several species of crabs within Raritan Bay, which complements the present study. Little else has been reported on the diets of the demersal fishery resource community of the Estuary, except for some brief incidental or anecdotal observations (Hall 1894; Merrill 1904; Breder 1922b; NJDEP 1975; Lynch *et al.* 1977; Lawler, Matusky & Skelly Engineers 1980; Conover *et al.* 1985).

To address this information deficiency, we report on the results of a seasonal study of the diets of common demersal fish species and the American lobster (*Homarus americanus*) collected in various parts of the Estuary. This study is roughly modeled on Festa's (1979) study for a shallow, south New Jersey estuary, and is intended to complement that effort, as well as the cursory dietary information in Able and Fahay (1998). These results are also compared to a comprehensive summary of most other dietary studies for the same predators in other Middle Atlantic Bight estuarine or coastal areas. A brief summary of the life history and habitat of major prey is also included because many of the habitat issues that managers have to deal with involve potential perturbations to the health and availability of common prey. This report is intended to be a ready source of trophic and habitat-use information for subtidal habitat management within this estuary.

METHODS

The strata and blocks (areas) that were sampled to collect fish and American lobster for stomach content analysis covered most of the Estuary (Figure 1), but were restricted to depths greater than 3.0 m because of survey vessel operational factors. The habitat characteristics of these strata are summarized in Table 1.

Six seasonal sampling periods were used to collect specimens for diet analysis: 1) July 8-12, 1996; 2) October 7-10, 1996; 3) January 27-30, 1997; 4) April 22-29, 1997; 5) August 18-28, 1997; and 6) November 17-20, 1997. In addition, a special collection of scup (*Stenotomus chrysops*) was made during June 9-11, 1997; data on scup from that collection are included in the August 18-28, 1997, sampling period. For each sampling period, approximately 40 blocks were randomly selected from about 200 possible blocks within the nine sampling strata.

Fish and American lobster samples were collected by a semiballoon otter trawl that had a 8.5-m headrope, 10.4-m footrope, 10.2-cm stretch-mesh nylon net, and a 3.5-cm stretch-mesh liner in the cod end. This trawl was towed for 15 min at ~3.7 km/hr (2 knots). Hydrographic data (*i.e.*, depth, salinity, temperature, and dissolved oxygen) were collected after each successful tow using a "Hydrolab Surveyor 4" multisensor. [Use of trade names is for information only, and does not represent endorsement by NMFS.] Details of the overall trawl survey are available in Wilk *et al.* (1998).

After the trawl was retrieved, the catch was sorted to species, weighed (g), and measured (0.1 cm). Then, up to about 10-15 specimens of each nonplanktivorous fish species were selected for analyses, as available. If available, additional samples were also collected for each apparent size class of a species. As feasible, the stomachs of large fish such as skates, dogfishes, and adult striped bass were examined in the field, or the eviscerated stomachs of such fish were placed individually in labeled plastic bags and quickly frozen. Small specimens were also bagged and frozen whole for later laboratory analysis.

To examine the diets in the field or laboratory, the contents of each stomach were carefully emptied onto a gridded

petri dish. The total stomach bolus volume was visually estimated by a side-by-side comparison with a set of variable-diameter, volume-calibrated (cm^3) cylinders. The bolus was separated and examined (by dissecting microscope, if necessary), then the stomach items or prey were segregated into the lowest identifiable taxon, counted, and measured for length (if possible), and finally, the proportion of each prey taxon or other item to the total stomach volume was estimated visually using the petri dish grid. Items or prey were identified to the lowest level practical using numerous taxonomic references, *e.g.*, Bigelow and Schroeder (1953), Gosner (1973), and Weiss (1995). The findings of clam siphons in winter flounder (*Pseudopleuronectes americanus*) and a few other predators prompted the collection of whole specimens of larger bivalve mollusks which commonly occurred in the area in order to examine their siphons for characteristics that could identify the specific source of the siphons that were found in the stomachs. These characteristics were used to develop a rough guide to siphons to improve the level of prey species identification.

The young-of-the-year (YOY) stages of most fish species (either as predator or prey) examined in the analyses were identified mostly using Bigelow and Schroeder (1953), Fitz and Daiber (1963), and a prepublication draft of Able and Fahay (1998). The transition lengths at 50% maturity, used to segregate juvenile and adults of certain fish species as part of the diet analysis, were based on O'Brien *et al.* (1993).

A literature review of target predator diets in the coastal Middle Atlantic Bight, the area between Cape Cod and Cape Hatteras, was used to create summary tables of the diet of each predator for comparison with results of the present study. In these tables, prey were listed by their relative overall importance using several ranking metrics, as available from the document source: mean percent frequency of occurrence (FO), mean percent contribution to total stomach content volume (TV), mean percent contribution to total stomach content weight (TW), mean percent contribution to total stomach content dry weight (TDW), mean percent contribution to total number of individual items in the stomach (TN), and an index of relative importance (IRI; FO x TV, or, FO x TW). Those comparative data available as FO and TV are the same as those used in the present study. The two "fresh condition" variables of TV and TW are nearly equivalent (*i.e.*, 1 g of prey as "fresh" weight approximates 1 cm^3 of prey as "fresh" volume) for most prey such as crustaceans, polychaetes, fish, shell-less mollusk meat, etc., but not for heavy-shelled prey (*e.g.*, sand dollars and mollusks in the shell) consumed whole (Steimle *et al.* 1994).

Our results for diets focus on dominant prey used by predators found in the Estuary. Dominant prey are generally defined as those contributing five or more percent to total stomach content volume, but prey of fishery management significance, such as juvenile fishery species, are also noted. The results are also presented in the order of predator sample abundance. For each predator, the results of this study are followed by the summary of the results of other studies for comparative purposes. Because of the relatively large number of predators considered in this predator-community-focused report, this strategy of reporting by predator sample abundance keeps relevant information together for each predator, and should be most convenient to users of this report. Summaries focused on common prey, with a brief review of their life history and habitat associations, are also presented.

RESULTS AND DISCUSSION

DIETS

Winter Flounder *(Pseudopleuronectes americanus)*

Hudson-Raritan Estuary Results

This species is a common, year-round inhabitant of the Estuary, and was collected in a range of sizes (6.1-45.0 cm total length (TL), mean of 20.0 cm) and strata, except in the central and coastal parts of Lower Bay, Stratum 3 (Figure 2). The 710 winter flounder which were examined ate 80 distinct, identifiable prey taxa, although only about 20 benthic invertebrates occurred at a relatively high FO. Endobenthic and epibenthic polychaetes (21+ species), amphipods (14+ species), and mollusks (10+ species) dominated the diet. This flounder also ate a range of food types, from plant detritus to algae to tunicates, including planktonic copepods (*e.g.*, *Pseudodiaptomus coronatus*), suprabenthic mysids and the amphipod *Gammarus lawrencianus*, as well as the epibenthic and endobenthic invertebrates. Typically, smaller species, earlier life stages, and/or fragments of larger benthic species were eaten. Some larger bivalve mollusks, *e.g.*, northern quahogs (*Mercenaria mercenaria*) and Atlantic surfclams (*Spisula solidissima*), were important in the diet, but only their siphons were nipped or torn off by this nearly toothless predator. The blue mussels (*Mytilus edulis*) that were found in the diet, *e.g.*, during April 1997 (Table 2a), were all spat less than 1 cm in length. The decapod crabs that were eaten – Atlantic rock crab (*Cancer irroratus*), blue crab (*Callinectes sapidus*), lady crab (*Ovalipes ocellatus*), and *Libinia* sp. – were all juveniles. A diversity of tube-dwelling amphipods were also eaten, especially *Ampelisca abdita*. Although several polychaete species were identified as being eaten, only the tube-dwelling *Asabellides oculata* and *Sabellaria vulgaris*, and the blood worm *Glycera* sp., were relatively common in the diet, *i.e.*, occurring in the top 20 prey ranked by FO (Table 2a). The percentage of empty stomachs that were found ranged from 2.9% in April 1997 to 42.2% in January 1997; this variable generally ranged between 6.7 and 16.9% for other sampling periods (Table 2a).

Unidentified organic matter (*i.e.*, detritus) ranked as the most frequently occurring diet item, followed by northern quahog siphons, *Ampelisca abdita*, Atlantic surfclam siphons, and unidentified polychaetes or their fragments (Table 2a). The TV of prey or prey type for all samples was again dominated by unidentified organic matter, Atlantic surfclam and northern quahog siphons, the mysid *Neomysis americanus* (hereafter, "*Neomysis*"), unidentified clam siphons, *A. abdita*, and unidentified polychaetes (Table 2a). Other prey individually represented a TV of less than 3%. As with FO, there was a high degree of intersample variability (Table 2a).

For most prey, there were only small seasonal variations in the degree of their use by winter flounder, but for some prey, there were obvious differences. For example, there was minimal use of clam siphons during January 1997 (Table 2a). At the same time, there was increased use of *Neomysis* and nemerteans. Seasonal predation peaks for other prey varied annually, *i.e.*, there was relatively high predation during one summer sampling, but not the other summer sampling, covered in this survey (*e.g.*, predation on juvenile Atlantic rock crabs and *Asabellides oculata*; see Table 2a).

Other prey or items found in winter flounder stomachs in lesser quantities were: green and red algae; anthozoans; nematodes; bryozoans; **gastropods** (juvenile *Crepidula* sp., *Lacuna vincta*, *Epitonium* sp., *Astyris lunata*, and *Nassarius trivittatus*); **bivalve mollusks** (*Solemya velum*, *Nucula* sp., *Mulinia lateralis*, *Tellina agilis*, softshell (*Mya arenaria*) siphons, and *Lyonsia hyalina*); **polychaetes** (*Phyllodoce* sp., *Eteone* sp., unidentified polynoids, *Nephtys* sp., *Nereis succinea*, *N. grayi*, *Nereis* sp., unidentified capitellids, *Asychis elongata*, *Clymenella torquata*, *Spiochaetopterus oculatus*, *Sabellaria vulgaris*, *Diopatra cuprea*, *Lumbrineris* sp., *Arabella iricolor*, *Pectinaria gouldii*, *Melinna cristata*, *Nicolea venustula*, and *Pherusa affinis*); **arachnids** (juvenile *Limulus polyphemus*); **copepods** (unidentified calanoids, harpacticoids, and cyclopoids, and the calanoid *Pseudodiaptomus coronatus*); **cumaceans** (*Diastylis* sp.); **tanaids** (unidentified); **isopods** (*Edotea triloba* and *Cyathura* sp.); **amphipods** (*Lembos websteri*, *Ericthonius* sp., *Gammarus* sp., *Jassa falcata*, *Hippomedon serratus*, *Orchomenella* sp., *Photis* sp., *Phoxocephalus holbolli*, *Stenothoe* sp., and *Parametopella* sp. (*cypris*?)); **mysids** (*Heteromysis formosa*); **decapod crustaceans** (*Pagurus* sp., *P. longicarpus*, xanthids (*Dyspanopeus*?), juvenile blue crabs, juvenile *Libinia* sp., and juvenile *Ovalipes ocellatus*); **echinoderms** (juvenile *Echinarachnius parma*); **tunicates** (*Molgula* sp.); and sand, shell hash, organic detritus, and manmade artifacts such as coal granules and synthetic fibers.

Winter flounder diet changed with size/growth. This shift in use of common prey was generally from small crustaceans (mysids and amphipods), polychaetes, and detritus by smaller fish, to more bivalve mollusk siphons by larger fish (Table 2b).

Winter flounder diet was examined for seasonal shifts in prey use as related to flounder size and maturity. Because of small sample sizes for each of the four size groups portrayed in Table 2b, the samples were pooled into two groups: juvenile (less than 20 cm TL; Table 2c) and adult (greater than or equal to 20 cm TL; Table 2d). In the summer-fall, juvenile winter flounder focused their feeding on northern quahog and Atlantic surfclam siphons, an amphipod (*i.e.*, *Ampelisca abdita* or *A. vadorum*), a tube-dwelling polychaete (*Sabellaria vulgaris*), and detritus, although *Neomysis* became important as prey in the winter (Table 2c). Other prey were relatively evenly used during most seasons or showed no seasonal pattern of use. For adults, the list of commonly eaten prey was condensed, with only four distinct prey being notable, and seasonal sample sizes were more irregular and often inadequate (Table 2d). Again, clam siphons were the dominant prey. The large bloodworm *Glycera* sp. and juvenile Atlantic rock crabs were the only other prey with any seasonal peaks.

Some studies of the winter flounder diet have shown that the diet closely reflects environmental conditions and prey availability in the areas in which the fish are collected (Frame 1974; MacPhee 1969). The winter flounder diet in this study also showed differences in prey use that varied among sampling strata, although sample sizes were small for some strata, particularly for the channel habitats, Strata 7-9 (Tables 2e,f). Some prey (*e.g.*, *Glycera* sp.) were eaten in similar proportion by juveniles and adults from the same strata areas of the Estuary. Other prey (*e.g.*, *Neomysis*, *Crangon septemspinosa* (hereafter, "*Crangon*"), and *Gammarus* sp.) were found in stomachs of juveniles or adults, but not both. The prey of juvenile winter flounder among different strata suggest no habitat-related patterns (Table 2e). There was no specific association of prey with channels (Strata 7-9), nor with the western or eastern areas, with the possible exception of the polychaetes *Glycera* sp. and *Sabellaria vulgaris* and northern quahog siphons in the western Strata 1-3, and Atlantic surfclam siphons in eastern Strata 4 and 6 (Table 2e). Predation by juveniles and adults on northern quahog siphons appears restricted to less-saline, western Strata 1-3 and 6, and predation on Atlantic surfclam siphons occurs in marine eastern Strata 4 and 5 and in channel Strata 7 and 8, as might be expected from the Atlantic surfclam's salinity preferences.

Comparisons with Other Diet Studies

Other winter flounder dietary studies in and near the Estuary, or within the coastal Middle Atlantic Bight, found a similar diet to that reported here, *i.e.*, opportunistic predation on benthic invertebrate macrofauna, especially polychaetes and amphipods, and on zooplankton by the smallest winter flounder sizes (Table 3). However, there was an unusually high degree of molluscan siphon nipping in this estuary compared to what has been reported elsewhere

(Tables 2 & 3; Lawler, Matusky & Skelly Engineers 1980; Stehlik and Meise 2000). A lesser degree of molluscan siphon nipping by winter flounder has been also reported in Canada (Medcoff and McPhail 1952), Cape Cod Bay (Gilbert and Suchow 1977), Long Island Sound (Carlson 1991), and near Woods Hole, Massachusetts (Frame 1974; Lux et al.1996), and in a few other studies (Table 3), however. It has been assumed that this siphon nipping is nonlethal to the mollusks, which can be fishery resources in their own right, and that the siphons regenerate (Irlandi and Mehlich 1996).

Windowpane *(Scophthalmus aquosus)*

Hudson-Raritan Estuary Results

Windowpane from YOY to adult (range of 2.5-35.0 cm TL, mean of 20.7 cm) are a year-round inhabitant of this estuary. Five hundred seventy windowpane were examined from all areas, although slightly greater quantities were available from the channels, especially in and near Raritan Channel, Stratum 9 (Figure 3). At least 37 prey taxa were identified in their diet. This prey spectrum included two mysid species, three or more decapod crustacean species, seven amphipod species, two or more copepod species, eight mollusk species, nine identifiable species of larval or juvenile fish, and some miscellaneous, nonprey items (green algae to coal fragments). This prey spectrum included a mix of benthic, suprabenthic, and pelagic species.

Despite the overall diversity of prey consumed, windowpane have a relatively focused diet. By FO for all samples, *Neomysis* was the dominant prey at 65.9% (range of 33.7-93.3%). It was followed in importance by *Crangon* at 31.7% (range of 23.6-53.0%) and the suprabenthic amphipod *Gammarus lawrencianus* at 9.5% (range of 0.8-39.0%). The other prey were eaten at a low FO (*i.e.*, less than 5%). The percentage of empty stomachs ranged from 2.0% in July 1996 to 33.7% in January 1997, and was between 10 and 24% in other sampling periods (Table 4a).

The TV paralleled the FO. *Neomysis* made up 57.1% of the overall diet by TV (range of 17.8-70.1%), with *Crangon* contributing 29% (range of 21.3-47.7%). Most other prey individually represented less than 0.1% of TV, although higher values occurred during some sampling periods (Table 4a).

Other prey or items found in windowpane stomachs in lesser quantities were: green algae; hydroids; nemerteans; **gastropods** (*Lacuna vincta*, juvenile *Crepidula* sp., *Nassarius trivittatus*, and *Astyris lunata)*; **bivalve mollusks** (*Mulinia lateralis*, *Nucula* sp., unidentified, and blue mussel spat); **cephalopods** (unidentified squid); **polychaetes** (unidentified); **copepods** (unidentified); **cumaceans** (unidentified); **amphipods** (*Corophium* sp., *Jassa falcata*, *Stenothoe* sp., *Hippomedon serratus*, and *Unciola* sp.); **mysids** (*Heteromysis formosa*); **decapod crustaceans** (*Pagurus longicarpus*, *Palaemonetes vulgaris*, and unidentified zoea); **fish** (unidentified juvenile flounder, unidentified juvenile fish, juvenile Atlantic menhaden (*Brevoortia tyrannus*), juvenile herring (*Alosa*), juvenile red hake (*Urophycis chuss*), juvenile cunner (*Tautogolabrus adspersus*), *Menidia* sp., juvenile Atlantic croaker (*Micropogonias undulatus*), and juvenile sand lance (*Ammodytes* sp.)); and sand and coal pebbles.

There was seasonal variability in the consumption of some prey (*e.g.*, the use of *Neomysis* peaked during the summer). The use of *Crangon* peaked in the winter-spring, although it was a major prey in July 1996 samples (Table 4a). *G. lawrencianus* was mostly consumed in the fall, especially in 1996, as was the red copepod *Pseudodiaptomus coronatus*.

There was a clear shift evident in prey use with windowpane growth (*e.g.*, from *Neomysis* as overwhelmingly dominant for windowpane less than 20.0 cm TL, to *Crangon* for windowpane at larger sizes, although *Neomysis* was dominant at all sizes (Table 4b). Small fish (*e.g.*, *Anchoa* sp.) also become more important for the larger-sized fish.

The results suggest some differences in prey use among strata and regions (Table 4c). *Neomysis* seems to be the basic prey in the Ambrose Channel to Verrazano Narrows area (Strata 6 and 7). *Crangon*, on the other hand, seems to be more often eaten in the central-western areas of the Estuary (*i.e.*, Strata 2, 3, 8, and 9). Other prey constituted an insignificant proportion (a TV of less than 10%) of the diet in most areas, except in Strata 4 and 5 (the marine shoals) where small or juvenile fish were eaten. Windowpane abundances were highest in channels (Figure 3) where *Neomysis* might be most abundant; see the "Forage Base" section for a discussion of the habitat of *Neomysis*.

Comparisons with Other Diet Studies

No previous focused studies of the diet of this species are known for this estuary, although Breder (1922b) commented that stomach contents of a few specimens that he examined "consisted of crustacean remains, probably schizopods [mysids]." In general, other studies of the diet of this species in the Middle Atlantic Bight found mysids (especially *Neomysis)*, *Crangon*, and "nekton" (*i.e.*, small fish and squid) to be primary prey (Table 5), but smaller-sized windowpane also ate copepods. For the continental shelf, Langton and Bowman (1981) reported 40-60% of the windowpane that they had examined had empty stomachs, but mysids and shrimp continued to dominate the diet offshore. The results of the present study are consistent with those of other studies and with Bigelow and Schroeder's (1953) general summary of the diet, except for the relatively high use of *G. lawrencianus* as prey in the present study.

Little Skate (*Raja erinacea*)

Hudson-Raritan Estuary Results

Little skate (mostly adults) were commonly found throughout this estuary during most seasons, except the summer (Figure 4; Wilk *et al.* 1998). The stomachs of 332 little skate (range of 33.0-49.0 cm TL, mean of 43.2 cm) were examined. Over 50 prey taxa or items, which ranged from green algae to a variety of small fish, were identified in the little skate diet. These prey taxa included 11 decapod crustaceans, 6 amphipods, 5 polychaetes, 8 mollusks, 10 identifiable fish, and miscellaneous prey or items (Table 6).

The most frequently found prey, overall, was *Crangon* at an FO of 82.8% (range of 77.2-92.9%). This prey was followed by juvenile or small Atlantic rock crabs at an FO of 49.5% (range of 7.1-75.3%), which were often found in a soft-shell stage, then by *Neomysis* at an FO of 16.3% (range of 6.1-28.5%) and *Ovalipes ocellatus* at an FO of 10.9% (range of 1.2-36.4%). The remaining prey had overall FOs of less than 10% (Table 6), with few empty stomachs.

The TV parallels the FO, with *Crangon* having 29.6% (range of 20.3-90.1%) of the TV, Atlantic rock crabs having 18.6% (range of 4.7-38.1%), and other prey having less than 10%, with the exception of the October 1996 sampling period when *O. ocellatus* had 15.6% (Table 6). A number of juvenile blue crabs were also eaten (Table 6).

Other prey or items found in little skate stomachs in lesser quantities were: unidentified green algae; hydroids; nematodes; nemerteans; **gastropods** (*Lacuna vincta*, *Nassarius trivittatus*, and *Astyris lunata*); **bivalve mollusks** (blue mussels, *Mulinia lateralis*, northern quahog siphons, and unidentified); **polychaetes** (*Lumbrineris* sp., *Spiochaetopterus oculatus*, *Arabella iricolor*, *Pherusa affinis*, *Diopatra cuprea*, and unidentified); **copepods** (*Pseudodiaptomus coronatus*); **cumaceans** (unidentified); **isopods** (*Cirolana concharum*, and *Cyathura* sp.); **amphipods** (*Leptocheirus pinguis*, *Hippomedon serratus*, *Unciola* sp., *Ampelisca abdita*, and unidentified); **decapod crustaceans** (unidentified, xanthids, *Pagurus pollicaris*, *P. longicarpus*, *Palaemonetes vulgaris*, *Dichelopandalus leptocerus*, and *Axius serratus*); **stomatopods** (*Squilla empusa*); **fish** (*Raja* sp. egg case fragments, juvenile rock gunnel (*Pholis gunnellus*), juvenile windowpane, northern searobin (*Prionotus carolinus*), unidentified searobins, sand lance, smallmouth flounder (*Etropus microstomus*), goby (*Gobiosoma* sp.), northern pipefish (*Syngnathus fuscus*), juvenile red hake, juvenile winter flounder, and juvenile silver hake (*Merluccius bilinearis*)); and sand, wood fragments, and human artifacts such as coal granules, iron rust flakes, and plastic particles.

Although little skate tended to be most common in this estuary in the cooler months, and sample sizes are relatively small in the summer, there appears to be a possible predation emphasis on Atlantic rock crabs and *Neomysis* during the cooler months (Table 6).

Comparisons with Other Diet Studies

No previous studies of the diet of this species are known for this estuary. However, the diet of this species has been studied elsewhere, both on the Middle Atlantic Bight continental shelf, and within other bays and estuaries (Table 7). These studies also show that small crustaceans dominate the little skate diet; with skate less than 20.0 cm TL eating small crustaceans (*e.g.*, copepods, mysids, and amphipods such as *Unciola irrorata*, *Gammarus annulatus*, *Leptocheirus pinguis*, and *Monoculodes edwardsi*), and with larger skate eating more decapod crustaceans, especially *Crangon*, *Cancer* sp., *Dichelopandalus leptocerus*, and hermit crabs (*Pagurus* sp.). However, squid and small fish (*e.g.*, sand lance, butterfish (*Peprilus triacanthus*), "herring" (*Alosa* sp.?), searobins, juvenile flounder, and red hake) were also eaten (Table 7). The diet of little skate from the Estuary (Table 6) is consistent with these other study results, and with the general dietary summaries reported in Nichols and Breder (1927) and Bigelow and Schroeder (1953).

Scup (*Stenotomus chrysops*)

Hudson-Raritan Estuary Results

Scup, mostly juveniles, were found from spring through fall in the Estuary and were relatively widespread in distribution, although with a tendency to be collected more often in the northern areas (Figure 5). The stomachs of 254 scup (range of 8.0-24.0 cm FL, mean of 12.9 cm) were examined. At least 39 items or prey taxa were identified in their stomachs, including 8 polychaetes, 7 amphipods, 6 decapod crustaceans, 6 mollusks, 2 mysids, and other taxa (*e.g.*, hydroids). The majority of these prey were benthic, except for mysids and *Gammarus lawrencianus* (Table 8).

The dominant items in the diet by FO were unidentified organic matter at 35.8% (range of 21.3-46.1%), *Neomysis* at 32.3% (range of 17.3-50.0%), bivalve mollusk remains at 14.3% (range of 1.3-26.7%), *G. lawrencianus* at 16.8% (range of 0.0-48.3%), *Crangon* at 15.2% (range of 3.9-30.7%), unidentified polychaetes at 14.2% (range of 6.7-35.5%), and *Ampelisca abdita* at 10.1% (range of 0.0-18.0%) (Table 8).

The contribution of prey to the overall TV parallels that to the overall FO in the same order of contribution (Table 8). There were few empty stomachs.

Other prey or items found in scup stomachs in lesser quantities were: unidentified hydroids; unidentified nemerteans; **gastropods** (juvenile *Crepidula* sp., unidentified, and eggs); **bivalve mollusks** (*Tellina agilis* and *Nucula* sp.); **polychaetes** (*Paranaites speciosa*, *Asabellides oculata*, *Sabellaria vulgaris*, *Pectinaria gouldii*, *Phyllodoce* sp., *Pherusa affinis*, and *Nereis* sp.); **copepods** (*Pseudodiaptomus coronatus* and unidentified calanoid); **cirripeds** (*Balanus* sp.); **tanaids** (unidentified); **isopods** (*Cyathura* sp.); **amphipods** (unidentified, *Orchomenella* sp.,

Photis sp., caprellids, *Unciola* sp., and *Corophium* sp.); **mysids** (*Mysidopsis bigelowi*); **decapod crustaceans** (xanthid crabs, juvenile blue crabs, and unidentified); and **fish** (silversides (*Menidia* sp.) and unidentified).

There were few, notable, interannual or seasonal differences in the diet of this basically warm-season species, with the possible exception of predation on *G. lawrencianus* in 1996 that was not evident in 1997 (Table 8).

Comparisons with Other Diet Studies

Within this estuary, the only previous known data on the scup diet is from the unpublished, preliminary 1976 results of the senior author, who examined 13 juvenile fish from Strata 1, 3, and 4. He found that the mostly frequently consumed prey were: the polychaete *Asabellides oculata* and copepods in Sandy Hook Bay, polydorid polychaetes and the dwarf surfclam *Mulinia lateralis* off Staten Island, and copepods and blue mussel spat on Romer Shoal (Stratum 4).

Michelman (1988) found that the juvenile scup diet in Rhode Island varied seasonally, but was still generally focused on benthic invertebrates, such as polychaetes (*e.g.*, maldanids, *Nephtys* sp., *Nereis* sp., and *Pherusa affinis*), small decapod crustaceans (*Pagurus* sp. and other crabs), *Neomysis*, amphipods (*Leptocheirus pinguis* and others), as well as mollusks, a burrowing anemone (*Ceriantheopsis americanus*), and fish eggs and larvae.

Most other studies found that scup less than 15 cm FL ate small invertebrates such as copepods, polychaetes, amphipods, decapod crustaceans (especially juvenile Atlantic rock crabs), and squid (Table 9); a number of qualitative or summary reports have found the same (Baird 1873; Peck 1896; Nichols and Breder 1927; Hildebrand and Schroeder 1928; Bigelow and Schroeder 1953; Allen *et al.* 1978). Linton (1901) and Sedberry (1983) found that the diet of scup gradually shifted with growth or size from small pelagic crustaceans to a variety of benthic taxa. The results of the present study are basically consistent with these other results, and show a strong reliance on benthic macrofauna and detritus as prey.

Summer Flounder (*Paralichthys dentatus*)

Hudson-Raritan Estuary Results

This species was most commonly collected during the summer and throughout the Estuary, but especially along the New Jersey shore (Figure 6; Wilk *et al.* 1998). The stomachs of 229 summer flounder (range of 13.8-69.0 cm TL, mean of 36.0 cm) were examined. Over 35 prey species or items were identified in their diet, including juvenile or small adults of 12 species of fish, 5 species of decapod crustaceans, *Neomysis*, and other taxa (Table 10).

Crangon with an FO of 49.5% (range of 34.4-78.0%) and *Neomysis* with an FO of 19.8% (range of 0.0-33.6%) were most frequently eaten. Unidentified fish were next with an FO of 13.2% (range of 0.0-14.0%), and juvenile *Ovalipes ocellatus* were prominent in the August 1997 stomach samples (Table 10).

The FO ranking was also followed by the TV ranking, with *Crangon* having a TV of 29.4%, and *Neomysis* having a TV of 11.4% (Table 10). The percentage of empty stomachs ranged from 10 to 50%, with the highest levels being found in the winter-spring period.

Other prey or items found in summer flounder stomachs in lesser quantities were: unidentified algae; hydroids; bryozoans; **gastropods** (*Crepidula* sp. and *Nassarius trivittatus*); **bivalve mollusks** (blue mussel spat, *Mulinia lateralis*, *Ensis directus*, *Nucula* sp., and *Tellina agilis*); **polychaetes** (*Sabellaria vulgaris* and unidentified); **copepods** (unidentified calanoid); **isopods** (*Cyathura* sp.); **amphipods** (caprellids, *Gammarus lawrencianus*, and *Ampelisca abdita*); **decapod crustaceans** (juvenile blue crabs, *Pagurus longicarpus*, and unidentified); and **fish** (juvenile scup, cunner, rock gunnel, juvenile searobins, juvenile weakfish (*Cynoscion regalis*), *Menidia* sp., juvenile striped searobin (*Prionotus evolans*), juvenile black sea bass (*Centropristis striata*), northern pipefish, juvenile *Alosa* herring, and juvenile grubby (*Myoxocephalus aenaeus*)).

Summer flounder were mostly collected in the spring and summer (Table 10), so seasonal shift could not be examined. There were few notable dietary differences between 1996 and 1997, although in 1997 summer flounder made greater use of *O. ocellatus* and unidentifiable juvenile flounder as prey. Most (85%) of the summer flounder examined were 30 cm TL or more, and probably not YOY. Despite the small sample size for YOY summer flounder, their diet differed little from that of larger fish: *Crangon* and *Neomysis* dominated the diet, with small *Ovalipes* and fish being of notable importance (Table 10).

With the number of samples being few (*i.e.*, less than 30 samples per stratum), and with the distribution of samples among strata being small, the results of interstrata comparisons were inconclusive, although there was a suggestion that *Crangon* were eaten commonly everywhere except in the Romer Shoal and Ambrose Channel areas (Strata 4 and 7). *Neomysis* were mostly found in stomachs examined from deeper channels (Strata 8 and 9) and near the Verrazano Narrows (Stratum 6), but also within Sandy Hook Bay (Stratum 1). The latter observations perhaps reflected some recent feeding in the unsampled Sandy Hook and Earl Naval Channels, located between Strata 1, 2, and 4.

Comparisons with Other Diet Studies

No previous studies of the diet of this species are known for this estuary.

In general, YOY summer flounder prey upon small fish (*e.g.*, silversides, mummichog (*Fundulus heteroclitus*), bay anchovy (*Anchoa mitchilli*), and sticklebacks), and *Palaemonetes*, *Crangon*, and *Neomysis* shrimps (Table 11). The species is highly opportunistic, but its diet shifts ontogenetically, from small crustaceans at smaller sizes, to fish prey at larger sizes. The diet of the predominantly YOY and juvenile summer flounders examined in the Estuary, dominated by crustaceans and small fish (Table 10), is consistent with other studies (Table 11), and with the generalizations of Hildebrand and Schroeder (1928), Ginsberg (1952), and Bigelow and Schroeder (1953), which were often based on small or ambiguous sample sizes.

Red Hake (*Urophycis chuss*)

Hudson-Raritan Estuary Results

Red hake were commonly collected in channels and the deep area below the Verrazano Narrows (Gravesend Bay, Stratum 6; Figure 7) and during most seasons (Wilk *et al.* 1998). The diet of 166 red hake (range of 4.3-39.0 cm TL, mean of 19.0 cm) was examined. These fish were primarily juveniles and were most frequently collected during cooler seasons. At least 33 prey species were identified in the diet, including 7 decapod crustaceans, 9 amphipods, *Neomysis*, 7 juvenile fishes, and other taxa from algae to mollusks. Most prey were benthic species.

Crangon with an FO of 77.6% (range of 56.3-100.0%), *Neomysis* with an FO of 31.7% (range of 0.0-48.4%), *Gammarus lawrencianus* with an FO of 20.9% (range of 0.0-100.0%), and unidentified organic detritus with an FO of 10.6% (range of 0.0-20.6%) dominated the diet.

Crangon dominated the diet's TV at 39.0% (range of 23.3-50.0%), followed again by *Neomysis* at 15.7% (range of 0.0-30.3%) (Table 12). The other prey were infrequently found in the stomachs, and few stomachs were found empty. The inadequate samples in 1996 and during warmer months (Table 12) prevent analysis of seasonal or interannual variation in the diet of this species.

Other prey or items found in red hake stomachs in lesser quantities were: green algae; hydroids; **bivalve mollusks** (*Nucula* sp., *Tellina agilis*, blue mussel spat, and unidentified); **polychaetes** (unidentified and *Pherusa affinis*); **copepods** (*Pseudodiaptomus coronatus* and unidentified calanoid); **isopods** (*Edotea triloba*); **amphipods** (*Phoxocephalus holbolli*, *Unciola* sp., *Ampelisca abdita*, *Corophium* sp., *Jassa falcata*, *Stenothoe* sp., *Hippomedon serratus*, and unidentified); **decapod crustaceans** (juvenile *Libinia* sp., *Pagurus longicarpus*, juvenile *Ovalipes ocellatus*, *Palaemonetes vulgaris*, and unidentified); **fish** (juvenile silver hake, juvenile red hake, smallmouth flounder, juvenile searobin, juvenile weakfish, juvenile cunner, unidentified juvenile flounder, and skate (*Raja* sp.) egg case fragments); and wood fragments.

Comparisons with Other Diet Studies

The diet of red hake from the Estuary (Tables 12) is consistent with other dietary studies for the species, with crustaceans being primary prey. The only previous, quantitative study of the diet of this species in Raritan Bay examined 45 subadults of this species in spring 1976 within Sandy Hook Bay and off Staten Island (Steimle, unpubl. data). That diet was dominated (*i.e.*, a TV of 92-100%) by *Crangon*. This result is consistent with Breder's (1922b) earlier comment that the few red hake that he looked at in Sandy Hook Bay in summer 1921 were "crammed full of large prawns"; these "prawns" were further defined as being *Crangon* in Nichols and Breder (1927).

In the nearby New York Bight apex (outside the mouth of the Estuary), over 1,000 red hake were examined and found to prey most commonly on *Crangon*, various polychaetes (mostly *Pherusa affinis* and *Nephtys incisa*), *Neomysis*, and benthic amphipods (Steimle 1985, 1994) (Table 13). Hildebrand and Schroeder (1928) observed that red hake that were caught off Sandy Hook had gorged on sand lance. In general, the summary of other studies (Table 13) and the treatise by Bigelow and Schroeder (1953) show that juvenile red hake eat a variety of small benthic and zooplanktonic invertebrates, but primarily crustaceans. Steiner *et al.* (1982) reported that juvenile red hake use shelter during the day (such as living sea scallops, *Placopecten magellanicus*) and leave this shelter to feed at night. As red hake grow, larger crustaceans such as decapods increase in importance in their diet, and some fish are also eaten (Table 13). Adult red hake were rarely collected within the Estuary (Wilk *et al.* 1998).

Weakfish (*Cynoscion regalis*)

Hudson-Raritan Estuary Results

Weakfish were another summer-fall inhabitant of the Estuary and were collected mostly in or near channels, especially in Stratum 9, Raritan Channel (Figure 8). The stomachs of 197 weakfish (range of 7.5-54.0 cm TL, mean of 17.7 cm) were examined. Over 20 prey species or items were identified in the diet, but they were dominated by crustaceans and a few juvenile or small fish. *Crangon* and *Neomysis* were the most frequently eaten prey, with only *Gammarus lawrencianus* and digested fish (probably bay anchovy) being of any relative importance (Table 14). There do not appear to be any consistent interannual differences in the diet, although there were pulses of the consumption of *Neomysis*, bay anchovy, and juvenile silver hake in the diet during certain sampling periods (Table 14).

Other prey or items found in weakfish stomachs in lesser quantities were: unidentified hydroids; **gastropods** (*Nassarius trivittatus*); **polychaetes** (unidentified); **crustaceans** (unidentified); **copepods** (*Pseudodiaptomus*

coronatus); **amphipods** (*Corophium sp.* and *Unciola* sp.); **decapod crustaceans** (*Dichelopandalus leptocerus*, juvenile *Ovalipes ocellatus*, juvenile Atlantic rock crabs, and juvenile blue crabs); **fish** (juvenile weakfish, juvenile Atlantic menhaden, butterfish, juvenile unidentified flounder, and juvenile windowpane); and human artifacts such as cellophane.

Comparisons with Other Diet Studies

The only previous information on the diet of this species known for this estuary are comments by Breder (1922b) that, when he examined a few adult weakfish from Sandy Hook Bay, he found that they had eaten fish such as Atlantic menhaden [juveniles?] , silver perch (*Bairdiella chyrsoura*), and anchovies, and squid and "prawns" [*Crangon*]. Another cursory diet examination by Lynch *et al.*(1977) of 25 juvenile fish from the Raritan River (western boundary of the Estuary) also noted that weakfish there also ate *Crangon* and fish. Within the upper Hudson River Estuary (above Manhattan Island), Gladden *et al.*(1988) reported that weakfish generally ate "fish and macroinvertebrates."

The summaries of the results of other weakfish studies (Table 15) and the generalized summary of Bigelow and Schroeder (1953) show that the diet of this species can vary substantially among estuaries. That is, it can be dominated by *Crangon* or small fish (especially bay anchovy and juvenile weakfish) in some estuaries, but by mysids (mostly *Neomysis*) or amphipods (*e.g.*, *Gammarus* sp.) in others. The earliest studies listed in Table 15 were less precise in defining prey, but the "shrimp," "prawns," or "mysids" that they noted are almost certainly *Crangon* and *Neomysis*, and suggest that there does not appear to be any substantial shift in dominant prey over the decades, at least in the past century. Other weakfish diet studies were not listed in Table 15 because of limitations or the general nature of their information, *e.g.*, Eigenmann (1902), Linton (1901), Tracy (1910), Nichols and Breder (1927), Hildebrand and Schroeder (1928), Lascara (1981), and Grecay (1990). The pattern of weakfish predation within the Estuary seems to be typical and focused on both *Crangon* and *Neomysis*, but small fish (*e.g.*, bay anchovy, butterfish, and weakfish) and *Gammarus* sp. amphipods are also important (Tables 14 and 15).

Spotted Hake (*Urophycis regia*)

Hudson-Raritan Estuary Results

Spotted hake of all size and age classes were collected commonly during the warmer months within the Estuary and mainly in channels, especially Raritan Channel (Stratum 9, Figure 9). The 162 spotted hake (range of 6.5-33.0 cm TL, mean of 18.3 cm) which were examined ate 30 prey taxa, ranging from hydroids to fish. The most frequently eaten prey were crustaceans (*i.e.*, *Crangon*, *Neomysis*, and *Gammarus lawrencianus*) and small fish (Table 16). The copepod *Pseudodiaptomus coronatus* was frequently eaten in half of the sampling periods. Few empty stomachs were found. *Crangon* dominated the overall stomach volumes with a TV of 45.7% (range of 31.3-60.9%) (Table 16).

Other prey or items found in spotted hake stomachs in lesser quantities were: unidentified nematodes; **bivalve mollusks** (unidentified, *Nucula* sp., blue mussel spat, and juvenile *Pitar morrhuanus*); **polychaetes** (unidentified, *Nereis* sp., and *Pherusa affinis*); **sipunculids** (unidentified); **crustaceans** (unidentified); **copepods** (unidentified); **amphipods** (unidentified, *Ampelisca abdita, Jassa falcata, Hippomedon serratus*, *Unciola* sp., and *Ericthonius* sp.); **decapod crustaceans** (juvenile Atlantic rock crabs, *Ovalipes oculata, Pagurus* sp., *Dichelopandalus leptocerus*, and *Palaemonetes* sp.); and **fish** (juvenile silver hake, juvenile red hake, juvenile searobins, and smallmouth flounder).

Comparisons with Other Diet Studies

No previous studies of the diet of this species are known for this estuary.

In general, other studies show that spotted hake usually eat larger epibenthic crustaceans and small fish (Table 17). Among the crustaceans eaten, *Crangon*, *Neomysis*, copepods, other decapod shrimp, and crabs were prominent in the diet of this species. The variety of fish identified in these other studies included bay anchovy and sand lance among others. This diet spectrum is consistent with Bigelow and Schroeder's (1953) review, the species' diet south of Cape Hatteras (Burr and Schwartz 1986), and with the results of the present study (Table 16).

Striped Searobin (*Prionotus evolans*)

Hudson-Raritan Estuary Results

Adults and juveniles of this species were collected mostly during the summer months, and in or near channels or within Sandy Hook Bay (Figure 10; Wilk *et al.* 1998). The 153 samples of striped searobin (range of 4.5-47.2 cm TL, mean of 21.4 cm) which were examined ate 34 identifiable prey taxa, but most frequently preyed upon *Crangon*, *Neomysis*, and other crustaceans, and upon small or juvenile fish. Of interest was the relatively frequent occurrence of small, approximately 1-3 mm, coal granules or pebbles in

their stomachs (Table 18). The TV was dominated (45.8%, range of 37.4-71.4%) by *Crangon* (Table 18). The diet was similar for 1996 and 1997 (Table 18).

Other prey or items found in striped searobin stomachs in lesser quantities were: unidentified hydroids; **gastropods** (unidentified, *Nassarius obsoletus*, and *N. trivittatus*); **bivalve mollusks** (*Nucula* sp., *Mulinia lateralis*, and *Ensis directus*); **cephalopod** (unidentified squid); **polychaetes** (unidentified); **crustaceans** (unidentified); **copepods** (unidentified and *Pseudodiaptomus coronatus*); **isopods** (*Edotea triloba*); **amphipods** (unidentified, *Corophium* sp., and *Unciola* sp.); **mysids** (*Heteromysis formosa*); **decapod crustaceans** (xanthid crabs and unidentified crab fragments); **fish** (smallmouth flounder, juvenile windowpane, juvenile anchovy, juvenile grubby, unidentified juvenile flounder, juvenile searobin, juvenile black sea bass, and juvenile stargazer (*Astroscopus* sp.)); and sand.

Comparisons with Other Diet Studies

There is only one other study of the diet of this species known for this estuary. Manderson *et al.* (1999) examined 35 stomachs of this species from shallow water in Sandy Hook Bay (near Stratum 1) and its Navesink River tributary, at its southern border. They reported an FO of 68% of YOY winter flounder in the searobin's diet, although *Crangon* and other crustaceans were the primary prey.

A summary of most other quantitative studies of the diet of this species from different areas shows that the diet was also based on crustaceans (*e.g.*, *Crangon*, *Neomysis*, copepods, amphipods, and juvenile crabs) and small or juvenile fish (*e.g.*, winter flounder, striped and northern searobins, scup, windowpane, bay anchovy, *Menidia*, northern pipefish, and probably others) as available (Table 19). Other, more generalized discussions of their diet, *e.g.*, Bigelow and Schroeder (1953), also note a broad spectrum of prey in the diet of this species, including crabs, amphipods, squid, bivalve mollusks, polychaetes, small fish (herring and winter flounder), and algae. In Richards *et al.*'s (1979) Long Island Sound study, they reported that the prey of age 1+ searobin varied with habitat type (*i.e.*, prey eaten on sandy bottoms were different from prey eaten on muddy bottoms). For example, on sandy bottoms, the razor clam (*Ensis directus*) was important. They also found that some predation showed no habitat-related differences (*e.g.*, on *Neomysis*, *Crangon*, and *Ovalipes ocellatus* and other crabs), and concluded that the diet of the adult striped searobin when at smaller sizes – although having a great deal of overlap with the sympatric but smaller northern searobin – tended to reduce competition for food by focusing on larger prey that were less specific in their habitat preferences. The results of the present study are consistent with the findings of other studies; although, again, one or more 2-5 mm diameter pebbles of coal or charcoal were observed in about 5% (range of 3-17%) of the stomachs (Table 18).

Northern Searobin (*Prionotus carolinus*)

Hudson-Raritan Estuary Results

This small species (range of 5.1-20.4 cm TL, mean of 15.1 cm) was collected mostly during the summer, and mainly in the eastern areas of the Estuary, *e.g.*, between Verrazano Narrows and Sandy Hook Bay (Figure 11; Wilk *et al.* 1998). One hundred three northern searobin stomachs were examined, and over 20 prey taxa were identified, which were mostly crustaceans. The reoccurring prey group of *Crangon*, *Neomysis*, and *Gammarus lawrencianus* were most frequently found in the stomachs. The contribution of prey to TV parallels their contribution to FO, although juvenile Atlantic rock crabs were of added importance to the diet of the large, August 1997 collection sample (Table 20). Coal pebbles were also found in these stomachs, but only during one collection, and then at an FO of 25% for the 87 fish examined (Table 20).

Other prey or items found in northern searobin stomachs in lesser quantities were: **hydroids** (unidentified); **nematodes** (unidentified); **bivalve mollusks** (blue mussel spat); **polychaetes** (unidentified); **copepods** (*Pseudodiaptomus coronatus*); **isopods** (*Edotea triloba*); **amphipods** (*Corophium* sp., *Ampelisca abdita*, and *Leptocheirus pinguis*); **mysids** (*Heteromysis formosa*); **decapod crustaceans** (*Pagurus longicarpus*); **fish** (juvenile smallmouth flounder, juvenile striped searobin, and juvenile black sea bass); and unidentified organic matter.

Comparisons with Other Diet Studies

No previous studies of the diet of this species are known for this estuary.

Some results of other studies of the diet of this predator show that, like its sibling species, the striped searobin, the northern searobin also preys principally upon crustaceans, with *Crangon*, *Neomysis*, amphipods, and copepods being prominent in the diet, but fish are eaten to a lesser degree (Table 21). This dietary pattern was also reported by Hildebrand and Schroeder (1928) and Bigelow and Schroeder (1953). The smaller adult size of the northern searobin, compared to the striped searobin, is a logical explanation for the difference in the use of fish (although juvenile herring, winter flounder, weakfish, bay anchovy, and others are reported as prey), and perhaps for the slightly

greater use of smaller macrofauna such as polychaetes and cumaceans. In Long Island Sound, Richards *et al.* (1979) reported on the diet of YOY and older northern searobins, and despite some ambiguity in their results, the YOY of this species appeared to prey principally upon *Neomysis* and copepods, based on numbers eaten. Larger fish were more focused on amphipods, isopods, and small decapod crustaceans as prey. Mann (1974) found that diet of this species varied with sediments and water depth. The summary of results (Table 21) also shows that the diet of northern searobin from this estuary (Table 20) is consistent with other studies (Table 21).

Striped Bass (*Morone saxatilus*)

Hudson-Raritan Estuary Results

Striped bass of small-to-medium size (range of 13.5-65.0 cm FL, mean of 33.2 cm) were generally only collected by trawl within the Estuary during the fall-winter, especially in western areas of the Estuary: Gravesend Bay (Stratum 6) and channels (Figure 12; Wilk *et al.* 1998). The 81 striped bass which were examined ate a diversity of prey, with greater than 20 identifiable species. The diet was dominated by a variety of small or juvenile fish and crustaceans (Table 22). Many stomachs per collection (up to 100%) were empty. *Crangon* again led in the diet with an FO of 62.3% (range of 54.5-75.9%) and TV of 50.3% (range of 15.0-100.0%). All other prey occurred or contributed less than 5% to TV, except *Neomysis* (Table 22).

Other prey or items found in striped bass stomachs in lesser quantities were: **polychaetes** (*Nephtys* sp.); **isopods** (*Cirolana* sp.); **amphipods** (unidentified and *Gammarus lawrencianus*); **mysids** (*Heteromysis formosa*); **decapod crustaceans** (*Axius serratus*); **stomatopod** (*Squilla empusa*); **fish** (rock gunnel, juvenile searobin, juvenile unidentified flounder, juvenile conger eel (*Conger oceanicus*), juvenile *Urophycis* sp., northern pipefish, bay anchovy, striped anchovy (*Anchoa hepsetus*), juvenile winter flounder, and juvenile grubby).

Comparisons with Other Diet Studies

There are no data on the diet of striped bass from within this part of the overall Hudson-Raritan Estuary. However, Lawler, Matusky & Skelly Engineers (1980) and Gardinier and Hoff (1982) did report on the striped bass diet in the Hudson River, 50 km north of the Verrazano Narrows. There they found that juveniles, less than 20 cm FL, fed on a mix of freshwater and marine organisms, including *Gammarus* and other amphipods (*e.g.*, *Corophium*, *Leptocheirus*, and *Monoculodes*), insect larvae, copepods, isopods (*e.g.*, *Cyathura* sp.), polychaetes, small decapod crustaceans (*Crangon* and mud crabs), and some small fish. While larger individuals were almost totally piscivorous, preying on river herring, Atlantic tomcod (*Microgadus tomcod*), bay anchovy, white perch (*Morone americana*), and killifish, they occasionally ate small crustaceans. Gladden *et al.* (1988), possibly summarizing the same data, also reported the species ate "fish and macro invertebrates" in the same study area. Twenty-four, 7-39 cm FL striped bass were also collected in the Raritan River during April 1976 - March 1977, but all of their stomachs were found empty (Lynch *et al.* 1977).

In general, most dietary studies of this species found seasonal and regional variability in prey (Table 23) that often reflected differences in local environmental conditions (*e.g.*, salinity), in the size of the fish examined, and/or in the time of year (*e.g.*, Bigelow and Schroeder 1953). There is a clear and well documented ontological shift in predation focus from small crustaceans (*e.g.*, copepods, amphipods, and mysids) and small or juvenile fish for the youngest and smallest striped bass, to larger fish and crustaceans (*e.g.*, crabs and shrimp) for the older and larger striped bass. The smaller-sized striped bass examined in the present survey ate a mix of small crustaceans and fish (Table 22).

Clearnose Skate (*Raja eglanteria*)

Hudson-Raritan Estuary Results

Clearnose skate were collected in the sandier, eastern polyhaline areas within the Estuary, such as Lower Bay, Gravesend Bay, East Bank, Romer Shoal, Sandy Hook Bay, and Raritan Channel (Strata 1, 3-6, 9; Figure 13), and during the summer (Wilk *et al.* 1998). The diet of the 71 clearnose skate which were examined (range of 49.0-86.0 cm TL, mean of 63.3 cm) included a diversity of crustaceans, fish, and other prey (Table 24). *Crangon*, juvenile or small Atlantic rock crabs and *Ovalipes ocellatus*, and fish were most frequently found in the stomachs and contributed most to overall stomach volumes (Table 24). No empty stomachs were found.

Other prey or items found in clearnose skate stomachs in lesser quantities were: unidentified algae; **mollusks** (unidentified); **amphipods** (unidentified); **mysids** (*Neomysis americana*); **decapod crustaceans** (*Pagurus longicarpus* and juvenile *Libinia* sp.); and **fish** (unidentified juvenile hake, juvenile striped searobin, juvenile black sea bass, rock gunnel, juvenile searobins, and gobies).

Comparisons with Other Diet Studies

No previous studies of the diet of this species are known for this estuary. In fact, information on the diet of this species in general is very weak, and only available from a

few studies (Table 25). In Delaware Bay, Fitz and Daiber (1963) examined the diet of this species and found that it also most commonly ate *Crangon* (*i.e.*, an FO of 60%), *Ensis directus* (*i.e.*, an FO of 36%), mud crabs (*i.e.*, an FO of 20+%), and to a lesser degree, a variety of other small crustaceans, bivalve mollusks, and small fish such as weakfish and windowpane. Prey volume or weight contributions were not noted, but numerically, *Crangon* was still the dominant prey, and *Neomysis* was second in importance. Fritz and Daiber (1963) also noted that in the fall the skate ate more *Neomysis*, decapod crustaceans, and fish, but in the spring they focused more on *Crangon* and *Ensis*. Kimmel (1973) examined a small collection of juveniles (less than 44 cm TL) of this species at the mouth of Chesapeake Bay and found that *Crangon*, *Ensis*, and the mud shrimp *Upogebia affinis* volumetrically dominated stomach contents, but that a variety of epifaunal invertebrates (especially crustaceans) and small fish (searobins and hake) were also eaten. The diet described by the 1973 Kimmel paper is consistent with the prey that Hildebrand and Schroeder (1928) noted in the few clearnose skate that they examined from inside Chesapeake Bay. In the present study, the only prey that was found that have not been previously reported to be important in the diet were Atlantic rock crabs and *O. ocellatus* (Tables 24 and 25).

Bluefish (*Pomatomus saltatrix*)

Hudson-Raritan Estuary Results

Juvenile, YOY (range of 7.0-13.5 cm FL, mean of 8.9 cm) bluefish were collected in the summer-fall in the Estuary, and mostly in or near channels (Figure 14; Wilk *et al.* 1998). The stomachs of 63 bluefish were examined; 62 of these were from one collection – August 1997. Fish, *Crangon*, and *Neomysis* dominated their diet (Table 26). The identifiable fish prey included mostly midwater forms: butterfish, silversides, anchovies, but also juvenile black sea bass.

The only other prey or items found in bluefish stomachs were unidentified algae and the polychaete *Nereis succinea*.

Comparisons with Other Diet Studies

Since only juvenile bluefish were collected and examined in this study, the following summary keeps that focus. Friedland *et al.* (1988) examined the diet of YOY bluefish in this estuary and reported that fish dominated the diet (by FO and TW) in Sandy Hook Bay (Stratum 1), especially bay anchovy, silversides, and killifish; however, *Crangon* were almost equally important, along with *Neomysis*. Breder (1922b) also notes that a small bluefish, also caught in Sandy Hook Bay, had a sand lance in its stomach. A limited study of the diet of bluefish in the Raritan River and adjacent western Raritan Bay found that juveniles (3-22.5 cm TL) collected by seine had eaten mummichog, bay anchovy, silversides, *Crangon*, *Palaemonetes* sp., and unidentified fish, while larger bluefish (greater than 37 cm FL) collected by gill net had eaten Atlantic menhaden, spot (*Leiostomus xanthurus*), bay anchovy, and *Crangon* (Lynch *et al.* 1977).

In the adjacent brackish Hudson River, YOY bluefish consumed a variety of fish during their summer residency, including juvenile striped bass, white perch, American shad (*Alosa sapidissima*), blueback herring (*A. aestivalis*), Atlantic tomcod, silversides, bay anchovy, and occasionally other species, as well as blue crabs (Juanes *et al.* 1993; Buckel *et al.* 1999) (Table 27).

In nearby southern Long Island, New York, and elsewhere in the coastal Middle Atlantic Bight, juvenile bluefish were reported to commonly eat small schooling fish such as silversides, bay anchovy, butterfish, killifishes, juvenile Atlantic menhaden, herring, and weakfish, as well as benthic fish such as winter flounder, spot, and Atlantic tomcod (Table 27; Greenley 1939; Tatham *et al.* 1984). Small crustaceans, such as *Palaemonetes* sp., *Crangon*, and *Neomysis* also dominated the YOY or juvenile bluefish diet (Table 27). The diet of the relatively small sampling of juvenile bluefish examined in the present study (Table 26) show that Friedland *et al.*'s (1988) findings are probably representative of the species' diet within the Estuary, are typical for this life stage of the species (Table 27), and are consistent with previous dietary summaries (Baird 1873; Nichols and Breder 1927; Hildebrand and Schroeder 1928; Bigelow and Schroeder 1953; Richards 1976).

Winter Skate (*Raja ocellata*)

Hudson-Raritan Estuary Results

Adult winter skate were collected from all areas of the Estuary during the cooler seasons, but they were especially abundant in or near channels (Figure 15; Wilk *et al.* 1998). The 57 winter skate (range of 36.0-77.0 cm TL, mean of 55.8 cm) which were examined ate a diverse diet of benthic invertebrates and fish. *Crangon* was also a major item in the diet, both in terms of FO and TV. Other crustaceans and a variety of small or juvenile fish (*e.g.*, Atlantic herring (*Clupea harengus*), sculpin, sand lance, and winter flounder) were also commonly consumed (Table 28).

Other prey or items found in winter skate stomachs in lesser quantities were: hydroids; **nematodes** (probably parasitic); **gastropods** (*Nassarius trivittatus*), **bivalve mollusks** (unidentified, *Mulinia lateralis*, and *Ensis directus*); **polychaetes** (unidentified); **mysids** (*Neomysis*); **decapod crustaceans** (unidentified crab fragments, *Pagurus longicarpus*, *Dichelopandalus leptocerus*, and juvenile blue crab); **stomatopods** (*Squilla empusa*); and **fish** (juvenile Atlantic her-

ring, juvenile red hake, goby, unidentified juvenile sculpin, and smallmouth flounder).

Comparisons with Other Diet Studies

No previous studies of the diet of this species are known for this estuary.

Nichols and Breder (1927) and Bigelow and Schroeder (1953) noted the importance of Atlantic rock crabs and squid in the diet of this species in New England waters, and that this species also ate a variety of other benthic invertebrates (*e.g.*, polychaetes, amphipods, shrimp, and razor clams) and small fish, such as juvenile skates, eels, herrings, smelt, sand lance, mackerel, butterfish, cunner, sculpins, and silver and *Urophycis* hake. The few available quantitative studies, including the present study, are consistent with this overview (Table 29), except that the present study shows a higher use of flounder as prey (Table 28).

Black Sea Bass (*Centropristis striata*)

Hudson-Raritan Estuary Results

There was a significant recruitment of juvenile black sea bass into the Estuary in the summer-fall of 1997. (Juveniles were rarely collected in other survey years, and adults were seldom found within the Estuary.) These juveniles were widespread in occurrence with a slight tendency to be found in or near channels (Figure 16; Wilk *et al.* 1998). The August 1997 survey collected 46 juveniles – 41 with nonempty stomachs (range of 2.9-29.0 cm TL, mean of 10.8 cm,), mostly at sites where colonies of redbeard sponge (*Microciona prolifera*) were collected. Various crustaceans dominated the diet, especially *Crangon*, *Neomysis*, and juvenile Atlantic rock crabs. The crustacean prey also included copepods, amphipods, isopods, and other small or juvenile decapods (Table 30). Several species of small or juvenile fish (*e.g.*, cunner, goby, Atlantic menhaden, and possibly anchovy) were also eaten, as were some other benthic invertebrate taxa.

Other prey or items found in their stomachs in lesser quantities were: **poriferans** (unidentified); **anthozoans** (unidentified); **nematodes** (unidentified); **gastropods** (juvenile *Crepidula* sp.); **bivalve mollusks** (*Ensis directus*); **polychaetes** (unidentified and *Asabellides oculata*); **copepods** (unidentified and *Pseudodiaptomus coronatus*); **isopods** (*Edotea triloba* and *Cirolana concharum*); **amphipods** (*Ericthonius* sp., *Stenothoe* sp., and caprellids); **decapod crustaceans** (juvenile *Ovalipes ocellatus* and *Pagurus* sp.); and **fish** (goby, juvenile cunner, and unidentified).

Comparisons with Other Diet Studies

No previous studies of the diet of this species are known for this estuary.

In other Middle Atlantic Bight estuaries, juvenile black sea bass prey principally upon small benthic crustaceans such as isopods, amphipods, small mud crabs, *Crangon*, mysids, and copepods, and upon small fish such as northern pipefish, anchovies, and silversides (Hildebrand and Schroeder 1928; Bigelow and Schroeder 1953; Richards 1963; Kimmel 1973; Allen *et al.* 1978; Festa 1979; Orth and Heck 1980; Werme 1981). Kimmel (1973) noted that polychaetes (*e.g.*, *Nereis* sp. and *Glycera* sp.) can be important, too, and that the dominant prey shifted with fish growth (*i.e.*, from small crustaceans such as *Neomysis* and various amphipods, to decapod crabs and polychaetes).

Most of the black sea bass collected in the Estuary were YOY and older juveniles (Wilk *et al.* 1998), but adults in other coastal areas have been reported to feed upon a variety of epifaunal and infaunal invertebrates, especially crustaceans, squid, and small fish (Bigelow and Schroeder 1953; Richards 1963; Mack and Bowman 1983; Steimle and Figley 1996). The diet of the juvenile black sea bass examined in the Estuary was dominated by small crustaceans (Table 30) and was similar to the diet of the species reported in other studies (Table 31).

Spot (*Leiostomus xanthurus*)

Hudson-Raritan Estuary Results

Spot are generally found in the Estuary in the summer-fall, and were especially common in or near the Raritan Channel (Stratum 9) and Sandy Hook Bay (Stratum 1, Figure 17) (Wilk *et al.* 1998). Forty-seven spot (range of 12.8-18.5 cm FL, mean of 15.4 cm) were collected in fall-winter 1996. The tube-dwelling amphipod *Ampelisca abdita* dominated the identifiable prey, but *Crangon* and *Neomysis* were also prominent. Other benthic invertebrates, including the copepod *Pseudodiaptomus coronatus*, constituted the rest of the stomach contents, which also contained a notable amount of unidentifiable organic matter or detritus (Table 32).

Other prey or items found in spot stomachs in lesser quantities were: green algae; **bivalve mollusks** (unidentified spat); **polychaetes** (unidentified); and **amphipods** (*Corophium* sp., *Gammarus lawrencianus*, and unidentified).

Comparisons with Other Diet Studies

No previous studies of the diet of this species are known for this estuary.

In southern New Jersey, Festa (1979) found that YOY spot ate copepods and amphipods (*e.g.*, *Ampelisca* sp.), while larger juveniles also included a variety of polychaetes in the diet. Elsewhere, various studies show that YOY spot ate calanoid and harpacticoid copepods, a variety of other small crustaceans including larvae, and detritus; while larger juveniles (11-16 cm FL) ate more amphipods such as *Ampelisca macrocephala* (Table 33). Within Chesapeake

Bay, Hildebrand and Schroeder (1928) reported that the species ate "small and minute crustaceans and annelids, together with smaller amounts of small mollusks, fish and vegetable debris". Smith *et al.*(1984) added that a wide diversity of plant material and benthic macrofauna was eaten. The diet of the spot examined from this estuary focused on small benthic organisms and detritus (Table 32), and is consistent with other dietary studies for the species (Table 33).

American Lobster (*Homarus americanus*)

Hudson-Raritan Estuary Results

A total of 47 American lobsters were collected during five seasons, mainly from Romer Shoal, Gravesend Bay, Chapel Hill, and Raritan Channel (Figure 18). The collections were a mix of juveniles and small adults (range of 2.8-9.9 cm carapace length, mean of 5.8 cm). The highly macerated state of the stomach contents, and the American lobster's known tendency to eat calcareous shell fragments, make identification of all true prey tentative. Species or items that could be identified from the diverse, particulate material in the stomach were included in this analysis, however. The dominant items evident in the stomachs were fragments of decapod crustaceans, especially Atlantic rock crabs, *Pagurus* sp., and *Ovalipes ocellatus*. Other items that were found suggest a range of taxa being eaten (*i.e.*, hydroids to skate egg cases), as well as human artifacts such as coal pebbles, fragments of plastic and rubber, and synthetic fibers (Table 34).

Other prey or items found in American lobster stomachs in lesser quantities were: **gastropods** (*Crepidula fornicata, Nassarius trivittatus, Lacuna vincta, Turbonilla* sp., and *Euspira* operculums); **bivalve mollusks** (*Mulinia lateralis*); **polychaetes** (unidentified, *Nereis succinea*, and *Spiochaetopterus oculatus*); **arachnids** (juvenile *Limulus polyphemus*); **cirripeds** (*Balanus* sp.); **decapod crustaceans** (*P. longicarpus, O. ocellatus*, and juvenile *Callinectes* sp.); and **echinoderms** (*Arbacia punctulata*).

Comparisons with Other Diet Studies

No previous studies of the diet of this species are known for this estuary.

Steimle (1994) examined the diet of American lobster collected outside the mouth of this estuary. He reported that the diet varied among three collection sites that were variably influenced by sewage sludge disposal, and among bimonthly collections, although few American lobster were collected during winter. At the least-sludge-affected sites (probably being most appropriate for comparison with this estuary), the American lobsters were primarily eating Atlantic rock crabs, unidentified fish, the polychaete *Pherusa affinis*, and algae (Table 35). He also noted obvious human artifacts in the stomachs, especially animal hair and synthetic fibers.

In Long Island Sound, Weiss (1970) reported American lobsters also ate crustaceans, especially Atlantic rock crabs, mollusks such as *Lacuna vincta* and the blue mussel, and the polychaete *Nereis virens*. Other American lobster diet studies have been conducted outside the Middle Atlantic Bight area (*e.g.*, in the sub-boreal Gulf of Maine and for Canadian populations). The diet of small American lobsters collected in the Estuary in the present study (Table 34) is consistent with the few available studies summarized in Table 35, and with the more general comments of Herrick (1911).

Tautog (*Tautoga onitis*)

Hudson-Raritan Estuary Results

Fifty-one tautog (range of 8.4-58.0 cm TL, mean of 37.5 cm) were collected and examined, primarily during the warmer seasons and from Romer Shoal, East Bank, Gravesend Bay, and, to a lesser degree, nearby areas (Figure 19). A variety of decapod crustaceans and mollusks were the most frequently eaten prey, with Atlantic rock crabs, xanthid crabs (including *Dyspanopeus sayi*), and blue mussels being prominent in the diet (Table 36).

Other prey or items found in tautog stomachs in lesser quantities were: hydroids; **gastropods** (unidentified, *Crepidula* sp., and unidentified eggs); **bivalve mollusks** (*Anadara ovalis* and juvenile northern quahogs); **cirripeds** (*Balanus* sp.); **amphipods** (*Gammarus* sp. and *Ericthonius* sp.); **decapod crustaceans** (unidentified and juvenile *Libinia* sp.); and shell hash.

Comparisons with Other Diet Studies

No previous studies of the diet of this species are known for this estuary, although Duffy-Anderson and Able (1999) mention that the diet of juvenile tautog held in cages in New York harbor appears to be "harpacticoid copepods, mysids, and amphipods."

Steimle and Shaheen (1999) summarized the diet of tautog, which has been resummarized in this report as Table 37. Dorf (1994) found that juveniles in Narragansett Bay, Rhode Island, ate various amphipods and copepods (mostly harpacticoids). Grover (1982) found a similar juvenile diet on the ocean side of Long Island, New York, as did Sogard (1992) in a southern New Jersey estuary. Nichols and Breder (1927) also noted seaweed in the diet of young tautog. The diet of older, 2-3 yr old juveniles was generally found to shift to mollusks, primarily blue mussels (Dorf 1994; Lankford *et al.*1995), but Festa (1979) reported mud crabs to be a primary item in the diet of larger juveniles in southern New Jersey.

Adult tautog are generally reported to prey primarily upon blue mussels, but also upon barnacles, crabs (*Pagurus* sp., Atlantic rock, and others), sand dollars (*Echinarachnius parma*), various amphipods, *Crangon* and other shrimp, American lobsters, scallops and other mollusks, and polychaetes (Hildebrand and Schroeder 1928; Bigelow and Schroeder 1953; Festa 1979; Steimle and Ogren 1982). Steimle (in review) found that besides blue mussels, the large anemone *Metridium senile* and razor clams (*Ensis directus*) can be important prey in Delaware Bay. The results of the present study (Table 36) reaffirm the importance of "shellfish," crustaceans, and mollusks, in the tautog diet.

Smooth Dogfish (*Mustelis canis*)

Hudson-Raritan Estuary Results

This relatively large (range of 55.0-111.0 cm TL, mean of 74.6 cm) visitor to the Estuary was collected in modest numbers (*i.e.*, 42 specimens) during the warm seasons of both survey years, and mostly from Romer Shoal, East Bank, Gravesend Bay, nearby eastern Lower Bay areas, and near the Raritan Channel (Figure 20). It primarily ate a variety of decapod crustaceans and mollusks, and an occasional fish. Among the decapod prey, *Crangon,* Atlantic rock crabs, and *Ovalipes ocellatus* were commonly eaten, and the most notable molluscan prey was the razor clam *Ensis directus* (Table 38).

Other prey or items found in smooth dogfish stomachs in lesser quantities were: **bivalve mollusks** (Atlantic surfclam); **cephalopods** (unidentified squid); **polychaetes** (unidentified and *Glycera* sp.); **decapod crustaceans** (*Pagurus pollicaris*, *Pagurus* sp., and *Libinia* sp.); **stomatopods** (*Squilla empusa*); and **fish** (juvenile Atlantic menhaden, northern pipefish, and lined seahorse (*Hippocampus erectus*)).

Comparisons with Other Diet Studies

No previous studies of the diet of this species are known for this estuary.

Rountree and Able (1996) examined the diet of YOY of this species in a southern New Jersey estuary and found small *Palaemonetes* sp. and *Crangon* shrimp as the dominant prey, followed by unidentified polychaetes and crabs, blue crabs, and a variety of other benthic invertebrates (especially crustaceans); very few fish were eaten (Table 39). These results were similar to an early study, near Atlantic City, New Jersey, by Breder (1921) who reported that various crabs, eel grass, detritus, and fish were the most common items in the stomachs of smooth dogfish less than 64 cm TL. Nichols and Breder (1927) noted a preference for eating young American lobster and blue crabs, as well as other crustaceans, fish, and a variety of benthic macrofauna. Bigelow and Schroeder (1953) also commented on the potential heavy predation of smooth dogfish on American lobsters in Buzzards Bay, Massachusetts, as well as predation on Atlantic menhaden and tautog. Festa (1979) examined 12 juvenile smooth dogfish from southern New Jersey and found that blue crabs dominated (*i.e.*, a TV of 91%) the diet, followed by "bay" [*Crangon*?] and *Palaemonetes* shrimp and juvenile weakfish. The present examination of the smooth dogfish diet in the Estuary (Table 38) shows that the species basically eats larger crustaceans and fish, which is consistent with the results of most other studies (Table 39).

Silver Hake (*Merluccius bilinearis*)

Hudson-Raritan Estuary Results

In general, silver hake were only collected as juveniles (range of 6.5-15.0 cm TL, mean of 10.1 cm) in the Estuary, and then primarily during the fall and in or near channels (Figure 21; Wilk *et al.* 1998). Juvenile silver hake were not commonly available for examination except in November 1997 when 29 were collected. Crustaceans were the most common and important taxa in the diet, especially *Crangon*, *Neomysis*, *Gammarus lawrencianus*, and *Ampelisca abdita,* but small or juvenile fish were also eaten (*e.g.*, silver hake, Atlantic menhaden, and probably anchovies). Both benthic and midwater fauna were eaten (Table 40).

Other prey or items found in silver hake stomachs in lesser quantities were: **crustaceans** (unidentified); **cumaceans** (unidentified); **isopods** (*Edotea triloba*); **amphipods** (unidentified, *Jassa falcata*, *Hippomedon serratus*, and *Unciola* sp.); **decapod crustaceans** (*Palaemonetes* sp.); and **fish** (juvenile Atlantic menhaden).

Comparisons with Other Diet Studies

No previous studies of the diet of this species are known for this estuary.

Table 41 summarizes dietary studies for juvenile and older silver hake that could be relevant to the present study. Schaefer (1960) and Steimle (1985) examined stomachs of this species collected just outside this estuary, and found that mysids (mostly *Neomysis*), *Crangon*, small unidentifiable fish, and YOY silver hake were the most important prey for near adult and adult fish. Schaefer (1960) also examined adults caught by hook-and-line on a surf-zone fishing pier in Long Branch, New Jersey (20 km south of the mouth of the Estuary), and found a slightly different diet from that found offshore. Inshore, he found that silver hake ate amphipods, *Crangon*, YOY silver hake, and mysids, in that order of relative importance. Richards (1963) reported a

similar diet in Long Island Sound. On the continental shelf, Sedberry (1983) and Bowman *et al.*(1987) found that juvenile (*i.e.*, less than or equal to 20 cm TL) silver hake ate various crustaceans, including euphausids and the hyperid amphipod *Parathemisto gaudichaudi*. Smaller, YOY silver hake (*i.e.*, less than 5 cm TL) ate benthic and pelagic amphipods; larger YOY (*i.e.*, between 5 and 10 cm TL) ate *Crangon* and *Dichelopandalus pinguis* [*leptocerus*?] shrimp, amphipods, small fish (sand lance and smaller silver hake), and squid. The juveniles collected in the Estuary during the present study ate a diet consistent with those studies noted in Table 41, with such studies as Jensen and Fritz (1960) and Vinogradov (1984), and with the generalizations of Bigelow and Schroeder (1953). Bowman *et al.* (1987) report that silver hake are mostly nocturnal feeders, and if so, mid-day collections might involve some loss of information by the digestion of softer prey. Few adult silver hake are collected in the Estuary (Wilk *et al.* 1998).

Less Abundant Predators

The following predators were collected in lesser quantities and in more limited areas. Their diets are only briefly documented here, with identifiable prey being listed in order of their relative importance to overall stomach content volumes.

Fourspot Flounder (Paralichthys oblongus)

Forty-one examples of this predator were collected from several strata, and ranged between 6.7 and 33.0 cm TL (mean of 15.1 cm). *Crangon*, unidentified fish, *Neomysis*, and unidentified decapod crustacean zoeae were prominent in the diet.

Grubby (Myoxocephalus aenaeus)

Twenty-six specimens, ranging between 3.8 and 13.0 cm TL (mean of 7.9 cm), were collected mostly in the Lower Bay to East Bank area (Strata 3 and 5). They ate *Crangon*, *Neomysis*, juvenile Atlantic rock crabs, juvenile black sea bass, the tubiculous amphipod *Corophium* sp., the isopod *Cyathura* sp., caprellid amphipods, and the sand-tube worm *Sabellaria vulgaris*.

White Perch (Morone americana)

Twenty-one white perch were collected, mostly in western Raritan Channel (Stratum 9), and ranged between 16.0 and 27.7 cm TL (mean of 21.0 cm). These fish ate *Crangon*, unidentified small or juvenile fish, unidentified crustaceans, gobies (*Gobisoma* sp.), *Neomysis*, *Palaemonetes* sp., and *Gammarus* sp.

Northern Kingfish (Menticirrhus saxatilis)

Sixteen kingfish were collected, mostly in the Lower Bay to East Bank area (Strata 3 and 5), and ranged between 7.5 and 16.5 cm TL (mean of 10.9 cm). They ate *Crangon*, *Gammarus lawrencianus*, anchovies, unidentified polychaetes, unidentified crab, *Neomysis*, and *Pagurus* sp.

Smallmouth Flounder (Etropus microstomus)

Twelve specimens of this flounder were collected, mostly in the Lower Bay to East Bank area (Strata 3 and 5), and ranged between 11.3 and 15.0 cm TL (mean of 12.7 cm). These fish ate *Crangon*, *Pagurus longicarpus*, *Neomysis*, *Pagurus* sp., and *Gammarus lawrencianus*.

Spiny Dogfish (Squalus acanthias)

Twelve spiny dogfish were collected, mostly in the Romer Shoal and Ambrose Channel area (Strata 4 and 7), and ranged between 76.0 and 80.3 cm TL (mean of 77.4 cm). They ate unidentified fish, Atlantic rock crabs, juvenile ocean quahog, *Pagurus pollicaris*, *Ovalipes ocellatus*, and northern pipefish.

Atlantic Tomcod (Microgadus tomcod)

Eleven Atlantic tomcod were collected in the Gravesend and northern Lower Bay area (Strata 3 and 6), and ranged between 7.5 cm and 9.7 cm TL (mean of 8.7 cm). They ate *Crangon* and *Gammarus lawrencianus*.

Oyster Toadfish (Opsanus tau)

Ten toadfish were collected, mostly in Raritan Channel (Stratum 9), and ranged between 11.5 and 24.5 cm TL (mean of 16.1 cm). They ate *Crangon*, juvenile Atlantic rock crabs, *Pagurus longicarpus*, and unidentified fish.

Rock Gunnel (Pholis gunnellus)

Nine samples of this species were collected in the Lower Bay to East Bank area (Strata 3 and 5), and ranged between 5.2 and 12.3 cm TL (mean of 9.4 cm). They ate *Neomysis*, *Photis* sp., unidentified isopods, *Leptocheirus pinguis*, and unidentified copepods.

Cunner (Tautogolabrus adspersus)

Nine cunner were collected, mostly in the Sandy Hook Bay to East Bank area (Strata 4 and 5), and ranged between 3.2 and 12.2 cm TL (mean of 5.5 cm). Unidentified amphipods, harpacticoid copepods, *Gammarus lawrencianus*, *Neomysis*, *Corophium* sp., *Ampelisca abdita*, *Ericthonius* sp., unidentified foraminifera, and *Unciola* sp. were found in their stomachs.

Northern Puffer (Sphoeroides maculatus)

Eight puffer were collected in Sandy Hook Bay (Stratum 1), and ranged between 7.3 and 16.2 cm TL (mean of 10.0 cm). They ate the sand-tube worm *Sabellaria vulgaris*, Atlantic rock crabs, unidentified crabs, hydroids, *Pagurus longicarpus*, *Ampelisca abdita*, gastropod eggs, barnacles, algae, and wood fragments.

Atlantic Croaker (Micropogonias undulatus)

Four croaker were collected from Raritan Channel (Stratum 9), and ranged between 12.6 and 18.0 cm TL (mean of 15.6 cm). They ate *Crangon*, an unidentified clam, *Ampelisca abdita*, *Neomysis*, *Glycera* sp., and unidentified fish.

Longhorn Sculpin (Myoxocephalus octodecemspinosus)

Three specimens were collected from the East Bank-Ambrose Channel area (Strata 5 and 7), and ranged in length between 9.0 and 29.0 cm TL (mean of 22.2 cm). They ate sand lance, *Crangon*, unidentified fish, and juvenile Atlantic rock crabs.

Conger Eel (Conger oceanicus)

Three juvenile congers were collected (*i.e.*, shaken out of discarded beverage containers brought up in the trawl) in Gravesend Bay (Stratum 6), and ranged between 20.5 and 30.2 cm TL (mean of 24.6 cm). They ate *Pagurus longicarpus*, juvenile Atlantic rock crabs, *Crangon*, and mud (xanthid) crabs.

Overall Perspective on Diets

The predator collection discussed in the preceding text appears representative of what is typically found within the Estuary. Wilk *et al.*(1998) listed 17 of the 20 predators examined in this dietary study as being among the most commonly collected species within the Estuary. The other species that they found to be common were pelagic or "forage" species such as bay anchovy, herrings, butterfish, and longfin inshore squid (*Loligo pealeii*) which are discussed subsequently. Three predators that were examined in this study, but that were not listed as the most common in the trawl survey, were smooth dogfish, tautog, and American lobster. These species were examined either because of their fishery importance (tautog and American lobster) or because of their being among the largest apex predators found within the Estuary (smooth dogfish).

The species occurring in the Estuary in the 1990s appear to be persistent since 1970s, *i.e.*, the dominant species were consistent with those reported by Wilk and Silverman (1976). The fish community defined by Wilk *et al.*(1998) in this estuary is also similar, with a difference of only one or two dominant species, to that found in other larger Middle Atlantic Bight estuaries, *e.g.*, Narragansett Bay, Rhode Island (Oviatt and Nixon 1973), Long Island Sound (Richards 1963), and Delaware Bay (Grimes 1983). However, as prey availability may differ in those estuaries, the diets discussed above may not adequately represent the situation for other estuaries.

Examination of diets from trawl-collected fish can involve biases related to the collection method. Some prey that were fresh and readily identified in the stomachs can be an artifact of within-trawl predation. This potential bias exists in most diet data based on trawl-caught samples, and is likely to involve the use of larger or motile epibenthic prey such as small fish, *Crangon*, and crabs that accumulate within the trawl's cod-end, or that are disturbed by the trawl doors, warps, footrope, or tickler chain to expose them to rapid-response predation. These results are also subject to other potential biases or errors that are typical of the method. For example, differential rates of prey digestion and stomach evacuation can be a bias, especially for afternoon collections (assuming diurnal predators often feed heavily in the morning), although American lobsters and other predators such as red hake are thought to be primarily nocturnal feeders.

FORAGE BASE

Examination of the diets of common predators provides insight into the value of various estuarine prey and habitats to support fishery populations. Also, the conservation of the habitat of prey that can be essential to fishery resources is a requirement of the Magnuson-Stevens Fishery Conservation and Management Act (October 1996). Consequently, for those prey which were examined in this study and which were found to be eaten more commonly than others, a brief overview of their life histories and a discussion of their habitat use are presented to facilitate effective habitat management. The following section summarizes what is known of the life histories and habitat use

of both the commonly eaten invertebrate prey as well as those fish that are less important to diets, but can be of interest to fishery management.

The prey that seem to be most widely used or to be eaten at the highest frequency or volume levels by one or more of the predators covered in the previous sections are summarized in Tables 42-44; Tables 42 and 43 list nonfish used as prey, and Table 44 lists fish used as prey. These prey are listed in order of their overall importance as prey within the Estuary, based on the ranking of their percent frequency of occurrence in the diet or percent contribution to total stomach content volume, relative to the predators examined in this study.

Dominant Invertebrate Prey and Their Life Histories and Habitats

Sevenspine Bay Shrimp (Crangon septemspinosa)

The epibenthic, sevenspine bay shrimp (or sand shrimp) ranked first in importance to overall diet volumes for most of the predators. It was the most common prey of little skate, juvenile summer flounder, juvenile red hake, weakfish, spotted hake, striped and northern searobins, juvenile striped bass, clearnose and winter skates, juvenile black sea bass, silver hake, and fourspot flounder (Tables 6, 10, 12, 14, 16, 18, 20, 24, 28, 30, and 40). Only winter flounder and tautog did not rely heavily on *Crangon* as prey, although it was occasionally eaten by both.

Crangon occurs on sandy to silty-sand sediments into which it can partially bury. It tolerates a wide range of salinity and temperatures, and occurs within estuaries and bays, offshore to about 90 m in depth, and from the sub-Arctic to Florida (Caracciolo and Steimle 1983). It is considered omnivorous, and will eat detritus, small invertebrates, and newly settled, postlarval fish such as flounder (Witting and Able 1993). It breeds throughout the warmer months, with prominent spring and weaker fall peaks known for some areas (Wehrtmann 1994). It can live for 2 yr and grow to about 7 cm TL.

Because *Crangon* is relatively motile and small, its abundance and distribution within the Estuary are not accurately known, although an unsuccessful effort was made to obtain such information (R. Reid, unpubl. data, National Marine Fisheries Serv., Highlands, NJ). It can avoid benthic grab samplers and pass through the mesh of standard trawls. Because of its importance to the diets of most fishery resources found in the Estuary, more should be known of its preferred habitats and sensitivity to human perturbation, including toxic chemical contaminant bioaccumulation. The species was also once found to be affected by "black spot disease," or chitinoclasia, within this estuary (Gopalan and Young 1975). The toxicity of chemically contaminated sediments in the Estuary to several crustacean species has been reported by Long *et al.*(1995), but tests were not conducted with *Crangon*, although tests on *Palaemonetes pugio*, a marsh dweller, were mentioned.

Neomysis americana

This mysid was generally second in overall importance, volumetrically, to diets. It was ranked first as prey for windowpane and second in overall importance to a variety of predators that focused upon *Crangon* as prey, except skates (Table 42). It was not found or identified in the diets of American lobster, tautog, and smooth dogfish in the size ranges examined in the present study.

Neomysis is a dominant component of the suprabenthic/planktonic community in most Middle Atlantic Bight estuarine ecosystems, but occurs widely along the Western Atlantic coast from Nova Scotia to the Caribbean Sea. Caracciolo and Steimle (1983) and Hargreaves (1995) report that it tolerates a wide range of salinities (*i.e.*, from marine to as low as 1‰) and temperatures (*i.e.*, from 0 to 25°C), and prefers to be over sandy sediment in depths less than 60 m. It occurs in swarms that are negatively phototaxic, and avoids strong light. It is omnivorous, eating mainly microalgae, zooplankton, and organic microdetritus. The abundance and distribution of *Neomysis* in the Estuary are unknown at present, but the species' photophobic nature suggests that deep channels and depressions in the Estuary with sandy sediments may be important daylight habitat, and when they may be most available as prey to demersal predators. As for *Crangon*, more needs to be known on *Neomysis*'s distribution, habitat use, and sensitivity to human perturbations in this estuary.

Gammarus lawrencianus

This semipelagic amphipod (also called "scud") ranked third in overall importance, being found in 68% of the diets examined. It was especially important as prey to windowpane, juvenile scup, juvenile red hake, juvenile weakfish, spotted hake, northern searobin, juvenile silver hake, and northern kingfish (Table 42).

G. lawrencianus was reported by Bousfield (1973) to occur on or over sandy or muddy areas of estuarine areas of Southern New England. Amphipods of the genus *Gammarus* typically move across the bottom on their sides, and their laterally compressed body allows them to move readily within cracks and spaces among algae and other objects. At summer breeding times, a species of *Gammarus* was observed swarming in the evening at the water surface within the Estuary (Grant 1984), suggesting a period of enhanced exposure to predation. Little is known of the relative abundance and distribution of *Gammarus* in this estuary, but the species' association with vegetation and other

shelter, as well as its semipelagic habits, make it difficult to survey. Sage and Herman (1972), in a rare reference to the genus in this estuary, found that *G. fasciatus* was only common in Sandy Hook Bay (Stratum 1) during November.

Atlantic Rock Crab (Cancer irroratus)

Juvenile or small Atlantic rock crabs were eaten by 60% of the predators, being most important to larger species such as little skate, striped searobin, summer flounder, clearnose skate, winter skate, American lobster, tautog, smooth dogfish, and to some juveniles such as those of black sea bass (Table 42). This prey was usually eaten in its YOY stage during the summer-fall, but soft-shelled stages of larger crabs were also eaten at all seasons.

The postmegalop, juvenile stages of this crab generally appear as part of the benthic macrofauna in early summer (Steimle and Stone 1973), and this coincides with their appearance in the diets of juvenile fish using this estuary (*e.g.*, winter flounder, scup, summer flounder, and black sea bass; Tables 2, 8, 10, 30) and in the diets of other small predators such as northern searobin (Table 20). Larger juvenile and small adult Atlantic rock crabs are eaten by other predators during other seasons; these larger crabs appear to leave this estuary in summer, except in deeper channels (Wilk *et al.* 1998). Studies of this crab suggest that, despite its common name, "rock crab," it is more commonly found on sand bottoms than on gravel and rock (*e.g.*, Jeffries 1966; Bigford 1979; Palma *et al.* 1999). However, the use of rough bottom or rock habitats by motile invertebrates and fish is poorly known because of sampling problems and inadequate survey effort (Steimle and Zetlin 2000). Reilly and Saila (1978) used diver surveys and reported mussel beds as a preferred habitat for juvenile Atlantic rock crabs off Southern New England. Atlantic rock crabs were most commonly collected by trawl in and near channels and throughout the marine, eastern part of the Estuary (Figure 22).

Lady Crab (Ovalipes ocellatus)

The lady or calico crab is a warm-season (April-December) ecosystem component, being collected from all areas and strata (Figure 23), although it is reported to prefer sands (Stehlik *et al.* 1991). Juveniles of this species were also most often found in diets. YOY seem to be available as prey in the summer and fall in this estuary, but larger (*i.e.*, 20-30 mm) crabs were collected in the spring too (L. Stehlik, pers. comm., National Marine Fisheries Serv., Highlands, NJ).

Right-Handed Hermit Crabs (Pagurus spp.)

Several species of hermit crabs (*Pagurus* spp.) were eaten by predators (*i.e.*, an overall FO of 64%), but these prey seemed only really important to American lobster and smallmouth flounder (Table 42). Usually only the distinct, distal ends of the legs and claws were identifiable in lobster stomachs. Two species were readily identified as prey, the small *P. longicarpus* and the larger *P. pollicaris*, the latter of which was rarely found as prey. Both species are considered omnivors/detritivors and are reported to be common on a wide range of habitats. *P. longicarpus* is found in shallow waters in the summer (including intertidal and lower salinity areas) from Canada to Texas, but migrates to deeper water and sandy bottoms as waters cool, where it often hibernates in pits that it digs (Rebach 1974). *P. pollicaris* tends to stay in deeper, more saline waters with sandy sediments.

Ampelisca abdita

This tube-dwelling amphipod was next in overall dietary importance, occurring in the diets of 56% of the predators examined. It was particularly important to the diets of winter flounder, windowpane, juvenile scup, juvenile weakfish, striped searobins, juvenile black sea bass, and juvenile silver hake (Table 42). Recent benthic surveys of this estuary (Cerrato *et al.* 1989) found this species to be common throughout the year in silty areas such as Sandy Hook Bay (Stratum 1), in western areas of the Estuary (Strata 2 and 9), and in Gravesend Bay (Stratum 6). Considering this distribution, it is curious that Long *et al.* (1995) commented on tests of the toxicity of sediment from various locations within the Estuary to this species, and noted that, in the 1980s and early 1990s, western Raritan Bay silty sediments (western parts of Strata 2, 3, and 9) were found to be toxic, while sediments from sandy areas in the northeastern third of the Estuary (eastern part of Stratum 3, and Strata 4, 5, 7, and 8) were relatively low in toxicity. Wide variance in annual abundances have been reported for this species (Steimle and Caracciolo-Ward 1989).

Northern Quahog (Mercenaria mercenaria) and Atlantic Surfclam (Spisula solidissima) Siphons

This type of prey was important only to winter flounder, and was eaten infrequently by other predators (Table 42). Because winter flounder and these two clams are dominant and fishery important species within the Estuary, the clams are included in this discussion. Northern quahogs are generally found in the fine-sand, silty central, western, and southern areas of the Estuary (de Falco 1967; McCloy 1984; Cerrato *et al.* 1989), basically in Strata 1-3 and 9, and in the deep silty area in Gravesend Bay (Stratum 6). Atlantic surfclams occur in the eastern, marine areas of the Estuary (Cerrato *et al.* 1989), *i.e.*, Strata 4-7. Thus, either one or the other of these two species of larger clams is available throughout the Estuary for siphon predation by winter flounder. The use of siphons seems unrelated to the availability of polychaetes and amphipods as potential prey, based on

the results of Steimle and Caracciolo-Ward (1989) and Cerrato *et al.*(1989), who show that these taxa were generally available, although at lesser biomass levels during the winter, and at quantities comparable to those in other estuaries (Steimle and Caracciolo-Ward 1989). Predation on clam tissue would appear not to have any energetic advantage, as clam tissue has one-half to one-third of the caloric food-energy value of polychaetes or crustaceans (Steimle and Terranova 1985), and tearing off a piece of relatively tough and muscular siphon must entail more effort than picking up unattached prey off the sediment surface. Thus, this focused use of siphons seems to be an enigma, although it could be related to a declining supply of benthos in the fall, as is typically found in many estuaries and coastal areas (Steimle 1985, 1990). Brief habitat summaries of other, less-used prey are presented in Table 43.

Habitat and Community Associations of Invertebrate Prey

Habitat Associations

The invertebrate prey discussed in the preceding section come from one of three general habitat-associated groups within the Estuary: endobenthic, epibenthic, and suprabenthic (semipelagic). The endobenthic (or infaunal) prey group includes organisms living within the sediment or in tubes upon the sediment surface, and consists primarily of mollusks (often only their siphons being eaten), polychaetes, and certain amphipods such as *Ampelisca abdita*, *Corophium* sp., and *Unciola* sp. (Table 42). This prey group generally uses sediment carbon (including bacteria and meiofauna) or surficial phytoplankton as food. This group is exploited as prey by a limited group of predators: winter flounder, scup, and spot (Table 42).

The epibenthic prey group consists of mostly motile species, especially small decapod crustaceans that move slowly across the sediment surface (*e.g.*, hermit, Atlantic rock, lady, and other crabs, and *Crangon*; Table 42). These prey tend to be omnivores, capable of using detritus as well as smaller organisms they encounter on the bottom, including larval fish (Witting and Able 1993). This group, especially *Crangon*, is exploited by the widest range of predators in this estuary.

The suprabenthic, or semipelagic, prey group consists primarily of *Neomysis*, seasonally augmented by gammarid amphipods such as *Gammarus annulatus* or *G. lawrencianus*, and by copepods that may be abundant near the bottom (*e.g.*, *Pseudodiaptomus coronatus*). These prey typically occur in swarms, and *Neomysis* can spend the daytime close to the bottom, but move up in the water column at night. They tend to be planktivors, although the gammarids may be capable of exploiting a wider range of small food items, including the scavenging of carrion.

The high use of crustaceans as prey in all three of these habitat-associated groups seems to be typical of food webs in many estuaries, and has apparently not been significantly altered for decades in the Estuary, *e.g.*, see Townes (1939). Townes (1939) also concludes that crustaceans are the most important prey of fish in New York coastal waters. He noted that "shrimp" (*Crangon* and *Palaemonetes*) and "opossum shrimp" (*Neomysis*) were the most important prey, but amphipods and other taxa were important, too.

Community Associations

Frame (1974), MacPhee (1969), and others have commented that the food of marine predators generally reflects the environmental conditions and habitats in which the predators live. Following is a brief review of where the aforementioned invertebrate prey can be expected to be found within the Estuary, based on available survey information. Because of logistic constraints, benthic invertebrate collections were not a feature of the 1996-97 survey. However, there have been several recent studies of the benthic community in the Estuary which have characterized the major community types and their distributions (Cerrato *et al.* 1989; Steimle and Caracciolo-Ward 1989; Wilber *et al.*, unpubl. data, National Ocean Serv., Charleston, SC).

Benthic organisms are known to exhibit wide variances in abundance, especially the smaller, short-lived species, but benthic communities, in general, are consistently associated with certain sediment characteristics and thus can be conservative over time, even if many community members fluctuate in abundance. Steimle and Caracciolo-Ward (1989) examined the information available on the Estuary's benthic community to the mid-1970s, Cerrato *et al.*(1989) examined the fauna in the mid-1980s, and Wilber *et al.*(unpubl. data, National Ocean Serv., Charleston, SC) examined the benthic fauna in the mid-1990s. All of these studies report both similarities and differences of major community types within the Estuary (as defined by dominant species), that are sediment and water depth related, for the most part.

Steimle and Caracciolo-Ward (1989) defined a silty sediment community numerically dominated by several species of polychaetes (*e.g.*, spionids, *Nephtys picta*, and *Sabellaria vulgaris*), mollusks (*e.g.*, *Mulinia lateralis*, *Acteon punctostratus*, *Tellina agilis*, and *Nassarius trivittatus*), and a few amphipods (*e.g.*, *Rhepoxynius epistomus*). Examination of biomass data identified: 1) *Nephtys incisa* as important in muddy areas (such as Strata 1-2 and 6); 2) *Glycera* sp., *Nassarius trivittatus*, and *Tellina agilis* as important in Lower Bay sands (Strata 3 and 4); 3) *Mulinia lateralis* as important in Sandy Hook Bay (Stratum 1); and 4) *Crangon*, *Pagurus* sp., and *Dyspanopeus sayi* as important in scattered areas. These authors noted that this community may have been stressed from a severe tropical storm (hurricane *Agnes*) that passed through the area during the previous year.

Cerrato *et al.* (1989) found a different mix of common species in the same areas reported by Steimle and Caracciolo-

Ward (1989). They noted dominant species and their general seasonal and spatial distributions; a majority of the benthic infaunal species that they found to be common in the mid-1980s were found to be numerically common prey items in the diets examined in the present study: *Ampelisca abdita*, *Asabellides oculata*, blue mussel spat, *Crepidula fornicata*, *Corophium tuberculatum*, northern quahogs, and Atlantic surfclams. This similarity of common infauna found by Cerrato *et al.*(1989) and common prey found in the present study suggests that the benthic community found in the mid-1980s persisted to the mid-1990 period of the diet survey. These benthic studies all reported that, overall, the benthic invertebrates within the Estuary were most abundant in a silty band that occurred: 1) from Sandy Hook Bay northwest to off Princes Bay, Staten Island (*i.e.*, basically Stratum 1 and the deeper areas of Strata 2 and 3); 2) adjacent to Raritan Channel (Stratum 9); and 3) in areas of Gravesend Bay (Stratum 6). The species which were most abundant in this band included those which were prey, such as *Ampelisca abdita*, *Asabellides oculata*, *C. tuberculatum*, and northern quahogs. Overall, benthic invertebrates were least abundant in the eastern, fine-to-medium sand habitats of Strata 4 and 5, and the eastern parts of Stratum 3; the species found to be most common in these areas were blue mussel spat and Atlantic surfclams, which are also prey species.

The most recent benthic survey of the Estuary, during October 1994 and June 1995 (Wilber *et al.*, unpubl. data, National Ocean Serv., Charleston, SC), noted the distribution of several benthic species that were primary prey in the present study; but their survey did not sample the channels (Strata 7-9). Atlantic surfclams and northern quahogs, the siphons of which were a major prey type for winter flounder, were most commonly collected in two separate areas of the Estuary: Atlantic surfclams within sandy Strata 4 and 5 and the northeastern third of Stratum 3, and northern quahogs in the silty parts of Strata 1 and 2 and lower half of Stratum 3. Blue mussels, a less common prey of several species, were collected in scattered locations across the eastern, sandy half of the Estuary, including near banks, shoals, and former borrow pits, in Strata 3-6. Blue mussels were especially common in June 1995, suggesting a strong spring 1997 recruitment occurred. The amphipod *Ampelisca abdita* was collected widely within the Estuary during both sampling periods, but especially in the silty parts of Strata 1-3 and 6, and irregularly in Strata 4 and 5.

The results of the most recent benthic studies by Cerrato *et al.* (1989) and Wilber *et al.* (unpubl. data, National Ocean Serv., Charleston, SC) are consistent, and suggest that certain recent benthic prey communities have persisted in their relative abundance and distribution within the Estuary. Their results are most likely representative of the prey community that would be available during this 1996-97 diet study, especially of those species that are relatively long lived such as the clams. There were, however, also benthic invertebrates they defined as abundant that did not appear in the present study to be readily used as prey: the minute capitellid "thread" worms *Heteromastis filiformis* and *Mediomastus* spp.; the spionid polychaete *Streplospio benedicti*; and the small bivalve mollusks softshell, *Tellina agilis*, *Macoma baltica*, *Gemma gemma*, and *Mulinia lateralis*. Steimle *et al.*(1994) found that winter flounder collected outside the Estuary often, but not always, ate what was most available (*i.e.*, abundant and of a suitable size) in the benthic community.

Fish as Prey and Their Life Histories and Habitats

Fish are also eaten by a number of predators in the Estuary, especially by summer flounder, weakfish, spotted and silver hakes, striped bass, bluefish, and clearnose and winter skates (Tables 10, 14, 16, 22, 24, 26, 28, and 40). The bay anchovy seems to be a favorite prey for many predators, but a number of demersal or benthic fish species are eaten frequently, too. It seems few juvenile or small fish are relatively immune from predation. None of the piscivors seem to be obligatory and almost all rely on epibenthic invertebrate prey to a high extent. Below is a summary of the fish observed in their stomachs, and some brief notes on habitats known to be commonly used by this prey group.

Twenty-six species of fish were identified in the stomachs of the predators examined in this study; other fish remains could not be identified to the species level (Table 44). Fish, at some level of identification, occurred in the diets of all but three predators, these exceptions being winter flounder, spot, and tautog. No specific fish species was widely eaten by predators. The maximum FO of prey among predators was 28% for anchovy being eaten by smallmouth flounder. Most fish that were found in the stomachs were juveniles, but some were mixed sizes, including adults of such small species as rock gunnel, northern searobin, smallmouth flounder, goby, northern pipefish, and lined seahorse. Most fishes eaten by predators were demersal, except anchovies, Atlantic menhaden, Atlantic herring, *Alosa* herring, *Menidia* sp., juvenile weakfish, butterfish, and possibly juvenile silver hake. Most fishes found in the Estuary seem to be preyed upon by larger fish, except elasmobranchs (*i.e.*, skates and dogfish sharks), although fragments of skate egg cases (possibly empty) were found in some American lobster stomachs.

Following are some brief notes on the life history and habitat use of those fish most commonly eaten as prey, presented as a convenient reference for habitat managers involved in this estuary.

Searobins (Prionotus spp.)

All but the adults of the striped searobin were eaten by a number of predators, including incidences of cannibalism (Table 44). Able and Fahay (1998) reported that juveniles of

both species prefer sandy sediments when they occur in estuaries during the late spring to fall, although northern searobin will move out of heated shallow waters to deeper, cooler water during mid-summer. Both species winter offshore.

Bay Anchovy (Anchoa mitchilli)

This is a common nektonic species and important prey for a variety of fish in this and other Middle Atlantic Bight estuaries (Houde and Zastrow 1991; Wilk *et al.* 1998). It is a small, schooling species that feeds on zooplankton (including fish and decapod crustacean eggs and larvae), and tolerates a wide range of salinity and temperature, although its abundance and distribution within estuaries can vary annually (Houde and Zastrow 1991). It grows to about 9 cm TL, and can live for about 3 yr. Spawning begins at age 1 and occurs in the spring and summer. The eggs hatch in about 1 day, and the larvae and early juveniles are common in the summer/fall and can be an important prey for juvenile weakfish (*e.g.*, Richards (1963), Van Engle and Joseph (1968), and others (Table 44)) and many other predators found in the Estuary. Wilk *et al.*(1998) show that, within the Estuary, bay anchovy was most frequently collected by trawls in Strata 1-3 (near Staten Island), 6, and channel Strata 8 and 9 (Figure 24), but were not found in the winter within this estuary.

Silver Hake (Merluccius bilinearis)

Although juveniles are commonly found within the Estuary during the cooler months (Wilk *et al.* 1998), all life stages of this species were reported rare within central New Jersey estuaries (Able and Fahay 1998). This species is usually considered nektonic, but Auster *et al.* (1997) reported that juveniles of this species occur at high densities in patches of amphipod tubes and other complex, structured benthic habitats found on the continental shelf.

Cunner (Tautogolabrus adspersus)

This small species is usually found year-round in marine parts of estuaries, and associated with structure such as shellfish and seagrass/algal beds, piers, pilings, bridge abutments, rock rip-rap, etc., although it can be less common in the winter (Able and Fahay 1998). In the trawl survey of Wilk *et al.* (1998), smaller sizes of cunner, which usually occur in stomachs, were usually collected when the trawl picked up some large debris (such as automobile tires), snagged on some object on the bottom, or caught a quantity of redbeard sponge. This reliance on shelter and rough bottom, which interferes with trawling, can explain why the species has been reported to be rare in previous trawl surveys of the Estuary (Berg and Levinton 1985). Its occurrence in the stomachs of open-bottom predators, such as summer flounder and skate (Table 44), suggests that cunner can be available away from, but probably near, shelter at times.

Silverside (Menidia sp.)

This common "baitfish" is usually found over shallow, sandy, nearshore areas, but was only identified in juvenile bluefish stomachs (Table 44). Conover and Murawski (1982) report that the species will move out of estuaries during the fall-winter in the northern part of its range.

Winter Flounder (Pseudopleuronectes americanus)

Although not normally considered a prey species, juvenile winter flounder were relatively common in skate diets in this estuary (Table 44), and Manderson *et al.*(1999) found that a limited sampling of adult striped searobins suggested that juvenile winter flounder were preyed upon in shallow water of Sandy Hook Bay (Stratum 1). Many of the unidentified small flounder remains found in the stomachs examined in the present study (Table 44) may also be this species, although both windowpane and smallmouth flounder are found in this size range. This is a well studied, estuarine-coastal species (Pereira *et al.* 1999), and its life history and habitat uses need not be reiterated here.

Sand Lance (Ammodytes sp.)

Able and Fahay (1998) reported that this species is common in shallow marine waters where it occurs in schools that often dive and burrow into sands when threatened. Skates appear to be its primary predator within the Estuary (Table 44). Sand lance were rarely collected in the recent trawl surveys within the Estuary (*e.g.*, see Wilk *et al.* 1998).

Butterfish (Peprilus triacanthus)

Able and Fahay (1998) summarized the life history and habitat use of this pelagic species which is found within estuaries during the summer, including the Hudson-Raritan (Wilk *et al.* 1998). This species was collected from all survey strata, although collections were relatively scarce within Sandy Hook Bay (Stratum 1). Able and Fahay (1998) noted that this species is negatively phototaxic and stays near the bottom during the day, making it most accessible to demersal predators at that time. However, only the juveniles of bluefish and weakfish seem to eat it (Table 44).

Early juveniles have been reported to be associated with and to accompany jellyfish when they appear inshore during the summer (Bigelow and Schroeder 1953).

American Eel (Anguilla rostrata)

Juveniles (elvers and "whips") of this eel were found in the stomachs of skate and adult spotted hake (Table 44). Able and Fahay (1998) reported that the juvenile and other phases of this species are common in estuaries, especially the Hudson River, where they occur in a wide range of habitats, silty to sandy, structured to unstructured.

Overall Perspective on Forage Base

Overall, the fish that were eaten as prey in this estuary were not as important as crustaceans and some other invertebrates as food for the bulk of the fish found in the Estuary. However, fish were a common prey type for some predators, and at times could have a notable impact on the survival and recruitment of some estuarine-dependent species. Understanding this relationship and its potential is important in developing a better understanding of the role of the benthic environment in fishery resource production.

Information on the diets of common fish and American lobster collected in the stressed Hudson-Raritan Estuary shows that these diets were still similar to the diets of the same species in other larger, less-stressed Middle Atlantic Bight estuaries. This suggests that the Estuary still functions tropho-dynamically like other, less-stressed areas. The study results also suggest that the Estuary's benthic habitat and macrofauna community are important to support a sustainable, multispecies fishery (and other biological resources such as wintering, fish-eating ducks). Steimle and Caracciolo-Ward (1989) and recent surveys all suggest that the Estuary's benthic fauna seem to be relatively healthy compared with other major estuaries, and that most of its expected community structure is still intact, although long-term trend data are absent. There could still be a potential problem with contamination of benthic prey by toxic substances from the Estuary's sediments and water, and from biotransfer up the food web, as suggested by Long *et al.* (1995).

ACKNOWLEDGMENTS

We thank Barbara Lamp for supplying New Jersey Marine Academy of Science and Technology and other student volunteers, including Andy Craig. We also thank colleagues Eileen MacHaffie, Steve Fromm, Joe Vitaliano, and Bob Reid. The cooperation of the crew of the NOAA R/V *Gloria Michelle* (Eric Nelson, Jeff Broeneck, and Jeremy Adams), Sally Swarts of UNICOR-ADP, and Sue Fromm are also recognized. Mike Fahay assisted in the identification of juvenile fish, and Pat Shaheen provided support on copepod taxonomy. We also thank Jason Link and others for their constructive comments.

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Table 1. Habitat characteristics of strata sampled in the Hudson-Raritan Estuary, 1992-97. (See Figure 1 for boundaries and areas of each stratum.)

Stratum	Depths (m)[a]	Sediments[b]	Salinity Range (ppt)[a]	Dissolved Oxygen Range (mg/l)[a]	Temperature Range (°C)[a]	Currents[c]	Habitat Types/ Structure	Dominant Benthic Community Types[b]
1- Sandy Hook Bay	3.5-10.0 (avg. = 6.2); deepest to east and off Sandy Hook Point	>50% silt-clay, except nearshore. Moderate to high chemical (toxic metals and organics) contamination.	~15-27	2.0-13.0; avg. = 8.7	0.3-23.8; avg. = 11.1	~<0.6 knots; north-south	Protected. Gradual (<1%) slope, except abrupt shoals parallel to Sandy Hook. *Ulva*, other algae, redbeard sponge, and terrestrial plant debris common in fall.	Numerically abundant infauna, often including *Ampelisca abdita*, northern quahogs, softshells, and blue mussels.
2- Raritan Bay	3.3-14.0 (avg. = 6.6); deepest near Raritan Channel	>50% silt-clay in and west of Keyport Harbor and near Earle terminal channel; gravelly coarse sand to silty sand in between and in shallower areas. Moderate to high chemical contamination in silty areas.	~16-26; lowest to southwest	3.6-13.2; avg. = 8.9	0.0-24.8; avg. = 11.0	~<0.7 knots; east-west	Semiprotected. Flat, gradual (<1%) slope; the 3-m trawl depth limit excludes much of the wide shallow area off the New Jersey coast, especially to the west; Raritan Channel is along the north boundary.	Patchy abundance, lowest to west. *Ampelisca abdita* often common in deeper, siltier areas near Raritan Channel; patches of Atlantic surfclam, northern quahog, and softshell abundance.
3- Lower Bay	3.3-13.8 (avg. = 6.6); deepest in West Bank borrow pits and near channels	Sand, except mud in borrow pits and deepest areas near Raritan Channel and west of Old Orchard Shoal. Moderate chemical contamination in silty areas.	~16-29; lowest to west	5.1-13.8; avg. = 8.9	0.0-26.1; avg. = 11.1	~<0.7 knots, except near Chapel Hill Channel; east-west,. but north-south near West Bank	Partially exposed. Gradual (<1%) slope, interrupted by borrow pits north and south of West Bank, bordered by channels south and east. Sponge patches in western areas.	Overall numerical abundance variable, lowest on flats off New Dorp Beach. *Ampelisca abdita*, other amphipods, bivalve mollusks, and polychaetes abundant in deeper, siltier areas along southern boundary.
4- Romer Shoal, Flynns Knoll, Swash Channel	3.5-9.0 (avg. = 7.0); deepest in Swash Channel.	Coarse to medium sand with shell. Low sediment chemical contamination.	~15-30	5.0-12.4; avg. = 8.8	0.9-23.7; avg. = 11.1	~0.4->2.5 knots, generally northwest-southeast and east-west	Exposed to the sea. Two shoals split by the Swash Channel, bordered by three channels. Blue mussel beds are common.	Overall abundance highest on Romer Shoal, <1000 ind./ m^2 elsewhere. Blue mussels and Atlantic surfclams common.
5- East Bank	4.0-22.0 (avg. = 7.5); deepest near Ambrose Channel and seaward of East Bank	Coarse to medium sand, and gravelly sand with shell near Breezy Point. Low chemical contamination.	~20-31	5.0-12.4; avg. = 8.8	0.6-23.0; avg. = 11.2	~0.2-2.0 knots, generally northwest-southeast	Exposed to the sea. Complex bathymetry including shoals and natural and dredged channels. Blue mussel beds are common.	Overall abundance highest near Breezy and Norton Points because of blue mussels. Atlantic surfclams common elsewhere.

6- Gravesend Bay, Narrows, West Bank	4.3-26.0 (below the Narrows); avg. = 10.1)	>50% silt near the Narrows and West Bank borrow pit; fine-medium sand to silty sand elsewhere. Low chemical contamination.	~19-29	5.0-12.0; avg. = 8.7	0.2-22.9; avg. = 11.2	~0.2-> 2.0 knots,north-south	Semiexposed. Seabed rapidly (>5%) slopes into main Hudson River mouth channel; West Bank shoal and several borrow pits to the west.	Overall abundance variable. *Ampelisca abdita* moderately common; blue mussels abundant near West Bank; polychaetes common in deeper, siltier areas.
7- Ambrose Channel (~600 m wide, ~7 km long)[d]	6.5-22.3 (avg. = 17.1); dredged to ~14 (45 ft)	Medium-coarse to gravelly sand. Low chemical contamination.	~21-31	5.0-11.7; avg. = 8.5	1.7-22.3; avg. = 10.7	~0.5->2.0 knots, within channel	Mechanically dredged to maintain authorized depth. Slopes increase at sides of channel. Accumulations of trash common in the western reach.	Overall abundance generally low, with spotty settlement of polychaete *Asabellides oculata*.
8- Chapel Hill Channel (~300 m wide, ~7 km long)[d]	6.6-15.2 (avg. = 10.3); dredged to ~9 (30 ft)	Variable sands. Low chemical contamination.	~20-30	5.9-11.6; avg. = 8.6	1.1-23.7; avg. = 11.4	~0.5-1.3 knots, east-west across channel	Mechanically dredged to maintain authorized depth. Slopes increase at sides of channel. Rocks are found in some places.	No data, but probably similar to Ambrose Channel.
9- Raritan Bay Channel (~265 m wide, ~16 km long)[d]	9.4-15.2 (avg. = 13.0); dredged to ~10.5 (35 ft)	Variable, silt-clay in west reach to mixed mud, gravelly sand, and sand in east reach. Moderate to high chemical contamination.	~20-29	5.0-12.0; avg. = 8.5	0.0-24.3; avg. = 10.9	~0.0-0.7 knots, within channel	Mechanically dredged to maintain authorized depth. Slopes increase at sides of channel.	Overall abundance low. *Ampelisca abdita* sometimes a dominant taxa.

[a] Channel characteristics are from National Ocean Service (1995).
[b] Sediment and benthic community descriptions are from the Cerrato *et al.*(1989) 1986-87 survey and Squibb *et al.*(1991).
[c] Current data from National Ocean Service (1994).

Table 2a. Summary of Hudson-Raritan Estuary winter flounder diet by sampling period during 1996-97, expressed as the percent frequency of occurrence of dominant prey or items (FO), and as the mean percent contribution of dominant prey or items to total stomach content volume (TV). (n = sample size; ES = percent of empty stomachs.)

	Sampling Period											
	Jul 96 (n = 89; ES = 6.7)		Oct 96 (n = 55; ES = 14.5)		Jan 97 (n = 135; ES = 42.2)		Apr 97 (n = 209; ES = 2.9)		Aug 97 (n = 83; ES = 16.9)		Nov 97 (n = 139; ES = 15.8)	
Prey	FO	TV	FO	TV	FO	TV	FO	TV	FO	TV	FO	TV
Unidentified organic matter	24.7	5.5	34.6	11.7	5.9	20.5	14.8	2.0	55.4	21.1	30.2	6.6
Northern quahog siphons	26.9	18.5	25.5	23.9	0.7	1.3	22.5	9.0	7.2	4.9	24.5	11.0
Ampelisca abdita	9.0	3.7	25.5	5.8	6.7	4.2	21.1	3.7	3.6	1.1	32.4	7.6
Atlantic surfclam siphons	11.2	2.6	25.5	9.0	0.0	0.0	45.9	31.3	2.4	1.1	22.3	21.5
Unidentified polychaetes	23.6	9.1	9.1	2.9	2.2	1.3	20.1	6.8	3.6	1.8	12.9	4.0
Neomysis americana	1.1	1.0	3.6	2.0	41.5	23.6	3.4	0.1	1.2	0.7	2.2	0.2
Unidentified clam siphons	2.2	0.9	1.8	0.3	0.7	1.3	11.5	6.9	18.1	12.7	1.4	1.7
Unciola sp.	0.0	0.0	20.0	5.8	7.4	6.8	0.5	<0.1	1.2	0.4	6.5	2.2
Blue mussel juveniles	2.2	1.4	3.6	0.6	0.0	0.0	7.3	10.5	0.0	0.0	0.0	0.0
Asabellides oculata	10.1	4.2	0.0	0.0	1.5	0.4	0.9	0.1	15.7	12.0	5.8	1.7
Corophium sp.	10.1	3.1	10.9	5.5	0.0	0.0	3.4	0.4	1.2	0.7	1.4	<0.1
Glycera sp.	14.6	11.7	1.8	1.7	0.0	0.0	3.4	1.0	2.4	6.7	2.9	2.5
Unidentified hydroids	2.2	2.1	0.0	0.0	0.0	0.0	11.9	5.1	8.4	7.8	2.9	0.9
Gammarus lawrencianus	6.7	4.5	5.5	2.6	5.9	6.3	1.0	0.3	0.0	0.0	3.6	1.2
Atlantic rock crab juveniles	19.1	10.5	0.0	0.0	0.0	0.0	1.4	1.5	1.2	3.3	1.4	0.3
Crangon septemspinosa	6.7	2.5	0.0	0.0	3.7	1.3	3.4	0.9	6.0	6.9	2.2	0.4
Nemerteans	9.0	3.9	0.0	0.0	1.5	19.8	7.7	3.7	0.0	0.0	0.0	0.0

Table 2b. Summary of Hudson-Raritan Estuary winter flounder diet by predator size group during 1996-97, expressed as the mean percent contribution of dominant prey or items to the total stomach content volume. (n = number of nonempty stomachs included.)

	Winter Flounder Size Group (cm TL)			
Prey	6.0 - 9.9 (n = 44)	10.0 - 19.9 (n = 291)	20.0 - 29.9 (n = 158)	30.0 - 45.0 (n = 85)
Neomysis americana	40.81	6.20	0.01	0.00
Detritus	14.47	11.80	3.40	1.70
Ampelisca vadorum	8.75	5.90	3.30	0.20
Unciola sp.	6.75	0.70	0.05	0.10
Unidentified polychaetes	5.34	5.85	3.70	1.40
Hydroids	5.34	2.32	1.90	3.50
Blue mussel spat	3.69	0.63	0.46	0.65
Northern quahog siphons	1.86	14.20	19.60	4.40
Atlantic surfclam siphons	1.80	8.10	32.30	69.50
Bivalve mollusk remains	0.85	3.01	0.74	12.50
Glycera sp.	0.00	5.26	4.32	1.00
Crangon septemspinosa	3.39	2.55	0.67	0.31
Ensis directus	0.00	0.27	5.10	0.02

Table 2c. Summary of Hudson-Raritan Estuary juvenile winter flounder (less than 20 cm TL) diet by sampling period during 1996-97, expressed as the mean percent contribution of dominant prey or items to total stomach content volume. (n = number of nonempty stomachs included.)

Prey	Sampling Period					
	Jul 96 (n = 63)	**Oct 96 (n = 39)**	**Jan 97 (n = 65)**	**Apr 97 (n = 65)**	**Aug 97 (n = 47)**	**Nov 97 (n = 56)**
Northern quahog siphons	10.50	23.77	0.01	7.68	3.59	22.15
Atlantic surfclam siphons	7.36	21.49	0.00	8.63	1.53	7.82
Ampelisca vadorum	3.98	11.20	4.28	7.03	0.93	8.62
Gammarus lawrencianus	7.42	1.68	13.06	0.00	0.00	0.65
Sabellaria vulgaris	3.34	3.20	0.39	0.00	19.52	0.00
Neomysis americana	0.11	0.00	62.47	5.80	0.00	0.17
Crangon septemspinosa	3.98	0.00	2.53	3.53	4.05	1.30
Unciola sp.	0.00	8.00	4.46	0.06	1.29	0.07
Detritus	6.64	17.68	2.96	5.14	26.10	22.15

Table 2d. Summary of Hudson-Raritan Estuary adult winter flounder (greater than or equal to 20 cm TL) diet by sampling period during 1996-97, expressed as the mean percent contribution of dominant prey or items to total stomach content volume. (n = number of nonempty stomachs included.)

Prey	Sampling Period					
	Jul 96 (n = 18)	**Oct 96 (n = 4)**	**Jan 97 (n = 7)**	**Apr 97 (n = 137)**	**Aug 97 (n = 16)**	**Nov 97 (n = 61)**
Northern quahog siphons	30.73	74.77	0.00	11.71	15.41	16.82
Atlantic surfclam siphons	2.74	0.00	0.00	49.95	0.00	47.79
Glycera sp.	20.25	0.00	0.00	2.42	37.25	0.65
Atlantic rock crab juveniles	10.93	0.00	0.00	3.55	1.28	0.11

Table 2e. Summary of Hudson-Raritan Estuary juvenile winter flounder (6.0 - 19.9 cm TL) diet by sampling stratum during 1996-97, expressed as mean percent contribution of dominant prey or items to total stomach content volume. (n = number of nonempty stomachs included.)

Prey	Stratum 1 (n = 31)	2 (n = 46)	3 (n = 71)	4 (n = 51)	5 (n = 13)	6 (n = 70)	7 (n = 17)	8 (n = 18)	9 (n = 16)
Glycera sp.	15.8	9.1	5.2	0.0	0.0	2.5	0.0	0.0	0.0
Sabellaria vulgaris	15.8	0.0	<1.0	<1.0	0.0	1.6	0.0	0.0	0.0
Pherusa affinis	0.0	0.0	7.8	1.8	0.0	1.1	6.2	0.0	0.0
Asabellides oculata	1.3	0.0	0.0	0.0	2.7	12.8	0.0	0.0	0.0
Ampelisca sp.	12.0	6.2	8.3	1.4	0.0	7.0	0.0	20.8	4.9
Gammarus sp.	<1.0	0.0	1.4	1.2	0.0	6.8	28.0	<1.0	0.0
Neomysis americana	0.0	2.2	13.3	20.5	51.1	4.1	3.5	20.0	18.8
Crangon septemspinosa	<1.0	0.0	4.0	5.1	9.8	2.9	0.0	0.0	0.0
Cancer sp. juveniles	0.0	0.0	<1.0	15.1	0.0	1.1	2.3	0.0	0.0
Northern quahog siphons	11.0	42.0	14.8	1.6	0.0	11.1	0.0	0.0	1.0
Atlantic surfclam siphons	0.0	7.2	2.0	20.7	0.0	10.5	2.4	7.9	0.0
Detritus	6.2	12.0	12.7	3.4	0.0	9.5	13.9	12.1	44.2

Table 2f. Summary of Hudson-Raritan Estuary adult winter flounder (20.0 - 45.0 cm TL) diet by sampling stratum during 1996-97, expressed as mean percent contribution of dominant prey or items to total stomach content volume. (n = number of nonempty stomachs included.)

Prey	Stratum 1 (n = 29)	2 (n = 30)	3 (n = 45)	4 (n = 39)	5 (n = 48)	6 (n = 18)	7 (n = 18)	8 (n = 5)	9 (n = 11)
Maldanopsis	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Glycera sp.	12.3	11.1	3.3	0.0	0.0	<1.0	17.5	0.0	0.0
Ampelisca sp.	6.9	14.5	1.0	0.0	0.0	<1.0	1.1	4.4	8.0
Cancer sp. juveniles	<1.0	0.0	4.0	<1.0	<1.0	20.8	1.3	0.0	0.0
Northern quahog siphons	14.5	31.6	47.1	0.0	<1.0	29.2	0.0	0.0	0.0
Atlantic surfclam siphons	6.0	6.8	16.3	77.3	78.8	1.3	42.1	11.8	0.0
Ensis directus	<1.0	1.1	0.0	13.4	0.0	0.0	0.0	0.0	0.0
Softshell siphons	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.3
Mulinia lateralis	<1.0	1.1	<1.0	0.0	0.0	<1.0	0.0	10.0	3.3
Detritus	2.0	4.9	3.5	0.0	<1.0	8.2	7.5	10.7	24.1

Table 3. Summary of other winter flounder diet studies for the coastal Middle Atlantic Bight. (Major prey taxa ranked in relative order of importance by: mean percent frequency of occurrence (FO), mean percent contribution to total stomach content volume (TV), mean percent contribution to total stomach content weight (TW), and mean percent contribution to total stomach content dry weight (TDW), as available from each source.)

Source	Study Area	Year(s) (month(s), season(s), and/or frequency)	No. Examined (size [TL cm]) or age range, mean size)	Primary Prey in Order of Importance by FO, IRI, TDW, TN, TV, and/or TW
Linton (1921)	Woods Hole, MA	1915-16 (May-Nov)	398 (2-22.5, ~8)	TV -- amphipods, copepods, ostracods, isopods, and "shrimp."
Tressler and Bere (1938)	Southern Long Island, NY	1938 (Jul-Aug)	120 (3-15)	FO -- copepods, amphipods, nematodes, ostracods, polychaetes, and isopods.
Smith (1950)	Block Island Sound, RI	1948-49 (seasonally)	Unknown	TW -- *Leptocheirus pinguis*, *Unciola irrorata*, and *Obelia* sp.
Richards (1963)	Long Island Sound - sandy site	1956-57 (monthly)	287 (4-17)	FO? -- nemertean, *Ampharete* sp., *L. pinguis*, *Neomysis*, *Nereis succinea*, and hydroids.
Richards (1963)	Long Island Sound - muddy site	1956-57 (monthly)	86 (8-16)	FO? -- *Nephtys incisa*, *L. pinguis*, and *Melinna cristata*.
de Sylva *et al.* (1962)	Delaware Bay shore	1958 (bimonthly)	95 (3-13)	FO? -- polychaetes, detritus, *Edotea* sp., and other isopods.
Pearcy (1962)	Long Island Sound (Mystic River, CT)	1958-59 (monthly)	359 (1-16)	TV (YOY) -- copepods to amphipods. TV (ages 1+) — amphipods to polychaetes.
Mulkana (1966)	Coastal Rhode Island ponds and rivers	1962 (Jul-Oct)	124 (3-8)	FO -- varies per estuary, mainly isopods (*Edotea* sp.), tanaids (*Leptochelia* sp.), polychaetes (*Nereis* sp. and spionids), and amphipods (*Ampelisca* sp. and *Lembos* sp.).
Lux *et al.* (1996)	Woods Hole, MA	Sep 1961 - Dec 1962 (weekly)	1,248 (12-42, mostly 22-38)	TW -- *Nereis* sp., *Glycera* sp., *Capitella* sp., *Macoma* sp., *Solemya* sp., softshell siphons, *Pagurus* sp., *Crangon*, and *Ampelisca* sp.
Frame (1974)	Buzzards Bay, MA	1968-69 (seasonally)	176 (ages 1+)	FO -- polychaetes, amphipods, and mollusks (*Nucula proxima*, *Tellina agilis*, and *Yoldia* sp.).
Steimle (1985)	New York Bight apex	1969-70 (summer)	196 (9-39, mostly 17-25)	FO -- *Pherusa affinis*, *Nephtys incisa*, amphipods, unidentified clam siphons, and isopods.
Festa (1979)	Little Egg Harbor, NJ	1972-77 (spring-fall)	97 (3-21) 45 (22-33)	TV -- *Palaemonetes* sp., polychaetes, clam siphons, and nemerteans. TV -- detritus, clam siphons, polychaetes, and *Ampelisca* sp.

Kurtz (1975)	Southern Long Island (NY) bays	Oct 1973 - Jun 1974	679 (13-28)	TW -- polychaetes (sabellids and terebellids), amphipods, and clam siphons.
Allen *et al.* (1978)	Hereford Inlet, NJ	1973-77 (biweekly/monthly)	106 (4-30)	FO -- polychaetes, amphipods, bivalve mollusks, *Crangon*, and isopods.
Steimle (unpubl. data)	Raritan Bay, NJ (Strata 1-4)	1976 (Mar-Jun)	84 (8-25)	FO -- *Asabellides oculata*, spionid polychaetes, hydroids, blue mussel spat, *Glycera* sp., and juvenile *Ensis directus*.
Homer and Boynton (1978)	Chesapeake Bay, MD	1977 (May-Jun)	168 (2-15)	TW -- *Scolecolepides viridis*, *Corophium lacustra*, softshells, *Macoma* sp., and *Nereis succinea*.
Lawler, Matusky & Skelly Engineers (1980)	Hudson River, NY	1979-80 (seasonally)	89 (mean = 170)	TV -- polychaetes and clam siphons.
Worobec (1984)	Charles Pond, RI	1979-80 (spring-summer)	181 (11-26)	TDW -- detritus, polychaetes, nematodes, and amphipods.
Conover *et al.* (1985)	Raritan Bay, NY	1982 (monthly)	409 (15-18)	TW -- *A. oculata*, *Gammarus* sp., algae, and other amphipods.
Steimle and Terranova (1991)	New York Bight apex	1982-85 (seasonally)	389 (mean = ~26)	FO -- *Ceriantheopsis americanus*, *Pherusa affinis*, *Lumbrineris* sp., and *Nephtys* sp.
Scarlett and Giust (1989)	Manasquan River, NJ	1984-86 (monthly)	273 (11-40, mean = ~25)	TV -- *Nereis succinea*, detritus, sand lance, clam siphons, hydroids, *Crangon*, and polychaetes.
Scarlett (1986, 1988)	Central New Jersey estuaries	1985-87 (winter-spring, monthly)	176 (12-37, means = 26-30)	TV -- *Nereis* sp., detritus, *Glycera* sp., other polychaetes, hydroids, *Cyathura* sp., and clam siphons.
Steimle *et al.* (1994)	New York Bight apex	1986-89 (monthly)	3,556 (18-30)	TV -- *P. affinis*, *Ceriantheopsis americanus*, *Nephtys incisa*, and *A. oculata*.
Bharadwaj (1988)	Narragansett Bay, RI	1987 (Nov)	266 (12-38)	FO -- *N. incisa*, *C. americanus*, *P. affinis*, and *Nereis* sp.
Carlson (1991)	New Haven Harbor, CT	Sep 1989 - Nov 1990	32 (10-15) 65 (16-20) 31 (21-25) 19 (26-29)	TW -- hydroids, crustaceans, and polychaetes. TW -- hydroids, snail feet, mysids, and polychaetes. TW -- *Streblospio* sp., hydroids, and *Ampelisca* sp. TW -- *Crangon*, *Ampelisca abdita*, and hydroids.
Timmons (1995)	Rehoboth Bay, DE	1994 (Aug)	36 (mean = 10)	TV -- polychaetes, detritus, and polychaete tubes.
Stehlik and Meise (2000)	Navesink River and Sandy Hook Bay, NJ	1996-98 (May, Jul, and Oct)	1,399 (1.0-45.0, mean = 10)	TV -- *Ampelisca* sp., softshell siphons, spionid and other polychaetes, copepods, mysids, and *Crangon*.

Table 4a. Summary of Hudson-Raritan Estuary windowpane diet by sampling period during 1996-97, expressed as the percent frequency of occurrence of dominant prey or items (FO), and as the mean percent contribution of dominant prey or items to total stomach content volume (TV). (n = sample size; ES = percent of empty stomachs.)

	Sampling Period											
	Jul 96 (n = 45; ES = 2.0)		Oct 96 (n = 59; ES = 13.5)		Jan 97 (n = 98; ES = 33.7)		Apr 97 (n = 163; ES = 23.3)		Aug 97 (n = 127; ES = 11.8)		Nov 97 (n = 78; ES = 10.3)	
Prey	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**
Neomysis americana	93.3	57.1	81.4	39.0	33.7	19.7	42.9	31.6	85.0	70.1	60.3	17.8
Crangon	44.4	41.5	28.8	16.7	53.0	47.7	36.8	45.5	23.6	24.8	34.6	21.3
Gammarus lawrencianus	2.2	1.1	39.0	22.8	4.1	3.0	1.2	0.1	0.8	0.5	11.5	4.8
Unidentified organic matter	2.2	0.2	1.7	<0.1	0.0	0.0	15.3	1.9	2.4	1.6	5.1	1.1
Ampelisca abdita	0.0	0.0	3.4	2.9	1.0	0.9	3.7	1.6	0.8	0.1	9.0	7.1
Pseudodiaptomus coronatus	0.0	0.0	8.5	7.7	0.0	0.0	0.6	1.4	0.0	0.0	2.6	1.9
Unidentified juvenile fish	0.0	0.0	3.4	1.6	1.0	<0.1	1.2	2.5	0.0	0.0	10.3	3.7
Juvenile *Anchoa* sp.	0.0	0.0	0.0	0.0	0.0	0.0	2.5	5.0	0.0	0.0	12.8	7.9

Table 4b. Summary of Hudson-Raritan Estuary windowpane diet by predator size group during 1996-97, expressed as the percent frequency of occurrence of dominant prey or items (FO), and as the mean percent contribution of dominant prey or items to total stomach content volume (TV). (n = number of nonempty stomachs included.)

	Windowpane Size Group (cm TL)							
	<9.9 (n = 126)		10.0 - 19.9 (n = 178)		20.0 - 29.9 (n = 229)		>30.0 (n = 24)	
Prey	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**
Neomysis americana	100.0	91.1	88.2	61.6	65.9	38.5	58.3	23.2
Crangon septemspinosa	7.7	4.9	35.4	23.6	54.6	51.0	66.7	56.3
Gammarus sp.	0.0	0.0	11.8	1.5	7.4	2.4	8.3	1.6
Anchoa sp.	0.0	0.0	5.6	12.3	1.3	1.4	4.2	8.7
Detritus	7.7	1.8	1.7	<1.0	12.7	<1.0	0.0	0.0

Table 4c. Summary of Hudson-Raritan Estuary windowpane diet by sampling stratum during 1996-97, expressed as mean percent contribution of dominant prey or items to total stomach content volume. (n = number of nonempty stomachs included.)

	Stratum								
Prey	**1 (n = 23)**	**2 (n = 24)**	**3 (n = 34)**	**4 (n = 18)**	**5 (n = 33)**	**6 (n = 25)**	**7 (n = 24)**	**8 (n = 16)**	**9 (n = 32)**
Neomysis	49.5	17.3	35.7	30.8	14.3	72.2	82.6	32.5	23.4
Crangon	44.4	77.7	52.8	21.2	36.2	26.1	6.1	64.6	76.5

Table 5. Summary of other windowpane diet studies for the coastal Middle Atlantic Bight. (Major prey taxa ranked in relative order of importance by: mean percent frequency of occurrence (FO), mean percent contribution to total stomach content volume (TV), and mean percent contribution to total stomach content weight (TW), as available from each source.)

Source	Study Area	Year(s) (month(s), season(s), and/or frequency)	No. Examined (size [TL cm]) or age range, mean size)	Primary Prey in Order of Importance by FO, IRI, TDW, TN, TV, and/or TW
Moore (1947)	Long Island - Block Island Sounds	1943-44 (monthly)	654 (18-34)	TV -- *Neomysis*, *Crangon*, chaetognaths, and larval fish (sand lance and silver hake).
Smith (1950)	Block Island Sound	1948-49 (seasonally)	Unknown, ~200	TW -- *Neomysis*, small fish, and squid.
Richards (1963)	Long Island Sound	1955-56 (seasonally)	Sand station - 49 (3-13) Mud station - 25 (3-13)	FO -- *Neomysis* and *Crangon*. FO -- *Neomysis*.
de Sylva *et al.* (1962)	Delaware Bay shore	1958-60 (Feb-Jul)	31 (5-17)	FO -- *Neomysis*, *Crangon*, and copepods.
Langton and Bowman (1981)	New Jersey - North Carolina	1969-72 (spring/fall)	163 (mean = 25)	TW -- *Neomysis*, pandalid shrimp, *Crangon*, and other decapod crustaceans.
Kimmel (1973)	Chesapeake Bay mouth	1971-72 (spring)	16 (7-17) 18 (19-24)	TV -- *Neomysis*, larval bay anchovy, and *Crangon*. TV -- *Neomysis*, *Crangon*, and bay anchovy.
Hickey (1975)	Eastern Long Island Sound	1972 (Apr-Dec)	120 (6-26)	TV -- *Neomysis*, *Crangon*, fish eggs, larvae, and "bait."

Festa (1979)	Little Egg Harbor, NJ	1972-77 (summer/fall)	4 (15-34)	TV -- *Crangon*, sand lance, *Neomysis*, and detritus. FO -- Detritus, *Neomysis*, and *Crangon*.
Allen *et al.* (1978)	Hereford Inlet, NJ	1973-77 (monthly)	60 (6-27)	FO -- Mysids, Crangon, amphipods, and decapod crab larvae.
Steimle and Terranova (1991)	New York Bight apex	1982-85 (seasonally)	131 (mean = ~27)	FO -- Mysids (*Neomysis* mostly), *Crangon*, and *Dichelopandalus leptocerus*.
Warkentine and Rachlin (1988)	New Jersey coast	Unreported	Unreported	FO -- *Neomysis*.
Carlson (1991)	New Haven Harbor, CT	Sep 1989 - Nov 1990 (monthly)	96 (11-34)	TW -- *Crangon*, bay anchovy, and naked goby (*Gobiosoma bosc*). FO -- *Crangon*, bay anchovy, goby, and *Neomysis*.

Table 6. Summary of Hudson-Raritan Estuary little skate diet by sampling period during 1996-97, expressed as the percent frequency of occurrence of dominant prey or items (FO), and as the mean percent contribution of dominant prey or items to total stomach content volume (TV). (n = sample size; ES = percent of empty stomachs.)

	Sampling Period											
	Jul 96 (n = 10; ES = 0)		Oct 96 (n = 33; ES = 0)		Jan 97 (n = 85; ES = 0)		Apr 97 (n = 116; ES = 0.8)		Aug 97 (n = 0; ES = N/A)		Nov 97 (n = 88; ES = 1.1)	
Prey	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**
Crangon septemspinosa	92.9	90.1	81.7	29.9	85.9	36.2	87.9	31.2	-	-	77.2	20.3
Juvenile Atlantic rock crab	7.1	4.7	24.2	9.0	75.3	38.1	44.0	19.9	-	-	35.2	9.7
Juvenile *Ovalipes ocellatus*	7.1	1.4	36.4	15.6	1.2	0.2	1.7	0.7	-	-	25.0	6.4
Unidentified organic matter	14.3	2.6	24.2	7.3	2.4	0.5	3.4	1.0	-	-	6.8	1.1
Ensis directus	0.0	0.0	3.0	1.8	2.4	0.6	17.2	6.1	-	-	18.2	3.8
Neomysis americana	7.1	1.2	6.1	0.6	15.3	2.4	28.5	9.3	-	-	13.6	2.8
Unidentified juvenile flounder	0.0	0.0	6.1	1.9	3.5	0.7	0.9	0.6	-	-	13.6	5.4
Juvenile blue crab	0.0	0.0	0.0	0.0	0.0	0.0	4.3	1.4	-	-	28.4	8.8
Pagurus sp.	0.0	0.0	6.1	0.7	1.2	0.4	5.2	1.6	-	-	18.1	5.9
Atlantic surfclam	0.0	0.0	6.1	9.5	0.0	0.0	4.3	1.6	-	-	3.4	0.5
Gammarus lawrencianus	0.0	0.0	6.1	6.0	2.4	0.4	0.0	0.0	-	-	6.8	1.1

Table 7. Summary of other little skate diet studies for the coastal Middle Atlantic Bight. (Major prey taxa ranked in relative order of importance by: mean percent frequency of occurrence (FO), mean percent contribution to total stomach content volume (TV), mean percent contribution to total stomach content weight (TW), mean percent contribution to total number of individual items in the stomach (TN), and an index of relative importance (IRI), as available from each source.)

Source	Study Area	Year(s) (month(s), season(s), and/or frequency)	No. Examined (size [TL cm]) or age range, mean size)	Primary Prey in Order of Importance by FO, IRI, TDW, TN, TV, and/or TW
Linton (1901)	Woods Hole, MA	1899 (summer)	32 (unknown)	FO? -- "Hermit, rock, blue, and mud crabs, shrimp, amphipods, polychaetes, squid, clams, fish."
Field (1907)	Woods Hole, MA	1905 (summer)	516 (~30-60)	FO -- Crabs (rock, lady, mud, and hermit), *Crangon*, fish (sand lance, butterfish, herring, and bothid flounder), squid, *Nereis* sp., *Ensis directus*, and amphipods.

Smith (1950)	Block Island Sound	1948-49 (seasonally)	Unknown, ~200 (unknown)	TV -- *Leptocheirus pinguis*, Atlantic rock crab, *Crangon*, other crustaceans, polychaetes, mollusks, small fish, and squid.
Fitz and Daiber (1963)	Delaware Bay	1954-55 (seasonally)	185 (mean = 45)	FO -- *Crangon*, *Lepidonotus squamatus*, *E. directus*, *Nereis* sp., *Pagurus* sp., and fish (northern searobin and windowpane). TN -- *Crangon* and *E. directus*.
Richards *et al.* (1963)	Long Island Sound	1956-57 (seasonally)	3 (9-11)	FO -- Copepods, *Neomysis*, *Heteromysis formosa*, and *Crangon*.
Vinogradov (1984)	Georges Bank - Southern New England	1968-74 (unreported)	253 (unreported)	TW -- Crustaceans, polychaetes, and fish.
McEachlan *et al.* (1976)	Offshore	1969-70 (seasonally)	785 (mean = ~45-50)	IRI -- Decapod crustaceans (*Crangon*, etc.), amphipods (*Leptocheirus pinguis*, etc.), and polychaetes (*Eunice* sp. and *Nereis* sp.).
Bowman *et al.* (1987) ceans.	Southern New England	1973-76 (spring/fall)	168 (16-20)	TW -- *Crangon*, Atlantic rock crab, and other crusta-
Sedberry (1983) *serrata*,	New York Bight	1976-77 (seasonally)	1,050 (5-30, disc width)	TV -- Atlantic rock crab, *Unciola irroratus*, *Byblis* and juvenile red hake. IRI -- Amphipods and decapod crustaceans.
Carlson (1991)	New Haven Harbor, CT	Sep 1989 - Nov 1990	115 (31-57)	TW -- Atlantic rock crab, decapod crustacean fragments, *Ovalipes ocellatus*, fish, and *Crangon*. FO -- Atlantic rock crab, *Crangon*, *O. ocellatus*, and *Pagurus* sp.

Table 8. Summary of Hudson-Raritan Estuary scup diet by sampling period during 1996-97, expressed as the percent frequency of occurrence of dominant prey or items (FO), and as the mean percent contribution of dominant prey or items to total stomach content volume (TV). (n = sample size; ES = percent of empty stomachs.)

	Sampling Period											
	Jul 96 (n = 58; ES = 7.0)		Oct 96 (n = 45; ES = 4.0)		Jan 97 (n = 0; ES = N/A)		Apr 97 (n = 76; ES = 1.0)		Aug 97 (n = 75; ES = 1.0)		Nov 97 (n = 0; ES = N/A)	
Prey	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**
Unidentified organic matter	36.2	14.7	37.8	8.9	-	-	46.1	14.8	21.3	3.4	-	-
Unidentified bivalve remains	22.4	11.2	8.9	7.3	-	-	1.3	0.4	26.7	8.0	-	-
Gammarus lawrencianus	48.3	20.8	17.8	10.4	-	-	0.0	0.0	0.0	0.0	-	-
Neomysis americana	50.0	24.4	42.2	13.5	-	-	19.8	9.2	17.3	2.8	-	-
Crangon septemspinosa	8.6	6.1	17.8	4.6	-	-	3.9	2.1	30.7	15.5	-	-
Ampelisca abdita	0.0	0.0	13.3	3.7	-	-	9.2	4.6	18.0	4.6	-	-
Unidentified polychaetes	6.9	4.1	6.7	2.8	-	-	35.5	15.2	9.3	2.2	-	-
Juvenile Atlantic rock crab	12.1	5.1	2.2	0.9	-	-	2.6	1.1	21.3	9.2	-	-
Juvenile blue mussel	1.7	0.5	2.2	0.3	-	-	31.6	10.2	1.3	0.2	-	-
Northern quahog siphons	1.7	1.5	13.3	7.0	-	-	0.0	0.0	17.3	9.8	-	-
Pagurus spp.	12.1	8.4	15.6	5.8	-	-	2.6	2.1	13.3	5.0	-	-
Ensis directus	1.7	1.0	0.0	0.0	-	-	1.3	7.4	13.3	8.8	-	-

Table 9. Summary of other scup diet studies for the coastal Middle Atlantic Bight. (Major prey taxa ranked in relative order of importance by: mean percent frequency of occurrence (FO), mean percent contribution to total stomach content volume (TV), mean percent contribution to total stomach content weight (TW),mean percent contribution to total stomach content dry weight (TDW), and an index of relative importance (IRI), as available from each source.)

Source	**Study Area**	**Year(s) (month(s), season(s), and/or frequency)**	**No. Examined (size [TL cm]) or age range, mean size)**	**Primary Prey in Order of Importance by FO, IRI, TDW, TN, TV, and/or TW**
Linton (1901)	Woods Hole, MA	1896-99 (summer)	51 ("YOY") 58 ("adults")	FO? -- Copepods and small crustaceans. FO? -- Small fish, squid, polychaetes, crabs, shrimp, amphipods, mollusks, and hydroids.
Richards (1963)	Long Island Sound - sand station	1956-57 (seasonally)	167 (2-15)	FO -- Polychaetes (*Ampharete* sp.), copepods (*Pseudodiaptomus coronatus*), and amphipods (*Photis* sp. and *Leptocheirus pinguis*).

Bowman *et al.* (1987)	Southern New England	1973-76 (spring/fall)	367 (<15)	TW -- Polychaetes, amphipods, decapod crustaceans (Atlantic rock crab), and squid.
Sedberry (1983)	New York Bight	1976-77 (seasonally)	138 (5-15)	IRI -- Amphipods (hyperids and gammarids) and polychaetes (*Potamilla reniforma* and *Glycera*)
			102 (15-30)	IRI -- Polychaetes, gammarid amphipods (*Ericthonius* sp.), and decapod crustaceans (Atlantic rock crab)
Steimle (unpubl. data)	Raritan Bay	1976 (Mar-Jun)	13 (YOY)	FO -- *Asabellides oculata*, copepods, polydorid polychaetes, *Mulinia lateralis*, blue mussel spat, and hydroids.
Michelman (1988)	Narragansett Bay, RI	1987 (seasonally)	66 ("juveniles")	TDW -- Polychaetes (maldanids, *Nephtys incisa*, *Nereis* sp., and *Pherusa affinis*), *Pagurus* sp., *Neomysis*, amphipods (*L. pinguis*, etc.), mollusks, *Ceriantheopsis americanus*, and fish larvae.
Steimle *et al.* (unpubl. data)	Delaware Bay	1989-94 (May/Jun, Aug/Sep)	246 (9.0-28.0, mean = 14.2)	TV -- blue mussels, *Ensis directus*, unidentified mollusks, *Metridium senile*, *Dyspanopeus sayi*, *Neomysis*, Atlantic rock crab, and unidentified fish remains.

Table 10. Summary of Hudson-Raritan Estuary summer flounder diet by sampling period during 1996-97, expressed as the percent frequency of occurrence of dominant prey or items (FO), and as the mean percent contribution of dominant prey or items to total stomach content volume (TV). (n = sample size; ES = percent of empty stomachs.)

Prey	Sampling Period											
	Jul 96 (n = 50; ES = 10.0)		Oct 96 (n = 8; ES = 25.0)		Jan 97 (n = 5; ES = 40.0)		Apr 97 (n = 38; ES = 50.0)		Aug 97 (n = 128; ES = 25.0)		Nov 97 (n = 0; ES = N/A)	
	FO	TV	FO	TV	FO	TV	FO	TV	FO	TV	FO	TV
Crangon septemspinosa	78.0	44.0	75.0	41.2	60.0	89.3	36.8	31.4	34.4	12.2	-	-
Neomysis americana	30.0	19.6	0.0	0.0	20.0	10.7	5.3	3.1	33.6	11.5	-	-
Unidentified juvenile fish	14.0	9.1	12.5	21.0	0.0	0.0	13.2	10.9	12.5	4.3	-	-
Juvenile *Ovalipes ocellatus*	2.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	32.0	17.1	-	-
Unidentified organic matter	2.0	0.3	0.0	0.0	0.0	0.0	5.3	0.2	8.6	3.9	-	-
Unidentified juvenile flounder	0.0	0.0	0.0	0.0	0.0	0.0	7.9	24.0	2.3	1.7	-	-
Juvenile windowpane	4.0	9.5	0.0	0.0	0.0	0.0	0.0	0.0	1.5	6.5	-	-
Juvenile Atlantic rock crab	4.0	7.2	0.0	0.0	0.0	0.0	0.0	0.0	7.8	7.0	-	-

Table 11. Summary of other summer flounder diet studies for the coastal Middle Atlantic Bight. (Major prey taxa ranked in relative order of importance by: mean percent frequency of occurrence (FO), mean percent contribution to total stomach content volume (TV), and mean percent contribution to total stomach content weight (TW), as available from each source.)

Source	Study Area	Year(s) (month(s), season(s), and/or frequency)	No. Examined (size [TL cm]) or age range, mean size)	Primary Prey in Order of Importance by FO, IRI, TDW, TN, TV, and/or TW
Linton (1901)	Woods Hole, MA	Unknown	24 (unknown)	FO -- Squid and fish (*e.g.*, juvenile scup).
Poole (1964)	Great South Bay, NY	1958-59 (summer/fall)	1,210 (25-67, mostly 25-42)	TW -- *Crangon*, juvenile winter flounder, juvenile blue crabs, *Neomysis*, and northern pipefish. FO -- *Crangon*, *Neomysis*, and northern pipefish.
de Sylva *et al.* (1962)	Delaware Bay shore	1958 (bimonthly)	26 (5-21)	FO -- *Neomysis*, *Crangon*, *Menidia*, unidentified fish, and other crustaceans.
Langton and Bowman (1981)	New Jersey - North Carolina	1969-72 (spring/fall)	44 (mean = 38)	TW -- *Loligo* squid, juvenile silver hake and scup, and Atlantic rock crab.

Kimmel (1973)	Mouth of Chesapeake Bay	1971-72 (spring/summer)	35 (4-20) 36 (20-48)	TV -- *Neomysis* and goby. TV -- *Neomysis*, *Crangon*, and bay anchovy.
Festa (1979)	Little Egg Harbor, NJ	1972-77 (summer/fall)	25 (6-24) 13 (26-65)	TV -- Fish (anchovy), *Crangon*, *Palaemonetes* sp., and *Neomysis*. TV -- Fish (juvenile searobin and winter flounder, silver perch, anchovy), and juvenile blue crab.
Smith and Daiber (1977)	Delaware Bay	Unknown	131 (31-73)	TV -- Juvenile weakfish, *Crangon*, *Neomysis*, bay anchovy, squid, *Menidia*, herring, and *Pagurus* sp.
Allen *et al.* (1978)	Hereford Inlet, NJ	1973-77 (biweekly/monthly)	57 (1-55)	FO -- *Crangon*, mysids, and fish.
Homer and Boynton (1978)	Chesapeake Bay, MD	1977 (summer)	198 (5-27)	TW -- Juvenile weakfish and spot, bay anchovy, juvenile Atlantic menhaden, *Crangon*, amphipods, juvenile croaker, mollusks, *Menidia, Neomysis*, and nematodes.
Steimle and Terranova (1991)	New York Bight apex	1982-85 (seasonally)	20 (mean = ~30)	FO -- *Neomysis*, fish, and amphipods.
Scarlett and Giust (1989)	Manasquan River, NJ	1984-86 (monthly)	90 (19-44, mean = ~31)	TV -- Juvenile blue crab, *Crangon*, and fish (mummichog, sand lance, juvenile winter flounder, and unidentified species).
Rountree and Able (1992)	Little Egg Harbor, NJ	1987-90 (summer)	137 (17-31, mean = 23)	TW -- *Menidia*, mummichog, *Palaemonetes* sp., and *Crangon*. FO -- *Crangon*, *Menidia*, *Palaemonetes sp.*, and mummichog.
Steimle *et al.* (unpubl. data)	Delaware Bay	1989-94 (May/Jun and Aug/Sep)	43 (23.0-56.0, mean = 35.3)	TV -- *Neomysis* and unidentified fish and mollusk remains.
Timmons (1995)	Rehoboth Bay, DE	1994 (summer)	36 (8-25, mean = 13)	TV -- *Palaemonetes* sp., juvenile blue crab, other crabs and shrimp, and mysids.

Table 12. Summary of Hudson-Raritan Estuary red hake diet by sampling period during 1996-97, expressed as the percent frequency of occurrence of dominant prey or items (FO), and as the mean percent contribution of dominant prey or items to total stomach content volume (TV). (n = sample size; ES = percent of empty stomachs.)

	Sampling Period											
	Jul 96 (n = 1; ES = 0)		Oct 96 (n = 0; ES = N/A)		Jan 97 (n = 62; ES = 5)		Apr 97 (n = 64; ES = 0)		Aug 97 (n = 7; ES = 14)		Nov 97 (n = 32; ES = 0)	
Prey	FO	TV	FO	TV	FO	TV	FO	TV	FO	TV	FO	TV
Crangon septemspinosa	100.0	50.0	-	-	85.5	47.4	91.2	46.2	71.4	47.5	56.3	23.3
Gammarus lawrencianus	100.0	50.0	-	-	8.1	9.5	10.3	1.5	0.0	0.0	43.8	18.8
Neomysis americana	0.0	0.0	-	-	48.4	30.3	39.7	14.5	28.6	26.2	12.5	2.4
Unidentified organic matter	0.0	0.0	-	-	8.1	0.9	20.6	6.2	14.3	3.3	3.1	1.0
Juvenile Atlantic rock crab	0.0	0.0	-	-	1.6	1.0	7.3	1.1	0.0	0.0	6.3	2.8
Unidentified fish	0.0	0.0	-	-	0.0	0.0	1.5	3.3	0.0	0.0	12.5	3.7
Dichelopandalus leptocerus	0.0	0.0	-	-	0.0	0.0	0.0	0.0	14.3	23.0	0.0	0.0

Table 13. Summary of other red hake diet studies for the coastal Middle Atlantic Bight. (Major prey taxa ranked in relative order of importance by: mean percent frequency of occurrence (FO), mean percent contribution to total stomach content volume (TV), mean percent contribution to total stomach content weight (TW), mean percent contribution to total number of individual items in the stomach (TN), and an index of relative importance (IRI), as available from each source.)

Source	Study Area	Year(s) (month(s), season(s), and/or frequency)	No. Examined (size [TL cm]) or age range, mean size)	Primary Prey in Order of Importance by FO, IRI, TDW, TN, TV, and/or TW
Richards (1963)	Long Island Sound	1956-57 (seasonally)	Sand station - 21 (9-20)	FO -- Polychaetes (*Glycera* sp.), amphipods (*Ampelisca* sp. and *Leptocheirus pinguis*), *Neomysis*, *Heteromysis formosa*, and *Crangon*.
Steimle and Ogren (1982)	New York Bight	1966-67 (Jul-Aug)	31 (mostly 33-36)	TV -- *Crangon*, unidentified tunicate, Atlantic rock crab, unidentified fish, and *Nereis* sp.
Steimle (1985)	New York Bight	1968-70 (summer)	219 (mostly 17-25)	FO -- *Crangon*, polychaetes (*Pherusa affinis* and *Nephtys incisa*), *Neomysis*, and amphipods (*Unciola* sp. and *L. pinguis*).
Vinogradov (1984)	Southern New England	1968-74 (spring/fall?)	1,892 (unreported)	TW -- Sipunculids, unidentified fish, crabs, squid, "shrimp," gammaridean amphipods, and bivalve mollusks.

Bowman *et al.* (1987)	Southern New England	1973-76 (spring/ fall)	"208" (<10)	TW -- Crustaceans (*Dichelopandalus leptocerus*), chaetognaths, amphipods, and decapod crustaceans.
			Part of above (10-20)	TW -- Crustaceans, amphipods (*Gammarus* sp.), decapod crustaceans (*Crangon*), and euphausids.
Steimle (unpubl. data)	Raritan Bay	1976 (Mar-Jun)	45 (Subadult)	FO -- *Crangon*.
Sedberry (1983)	New York Bight	1976-77 (seasonally)	716 (5-20)	IRI -- Amphipods (*Unciola irrorata*) and copepods.
			425 (25-50)	IRI -- Amphipods (*U. irrorata*), Atlantic rock crab, fish, and ocean scallops.
Luczkovich and Olla (1983)	Coastal New Jersey	1979-80 (1 yr, monthly)	130 (2-9)	FO -- Unidentified crustaceans, decapod crustaceans (*Crangon*), amphipods (*Unciola* sp., *L. pinguis*, *Monoculodes* sp., and *Ericthonius* sp.), calanoid copepods, and mysids.
Steimle and Terranova (1991)	New York Bight apex	1982-85 (seasonally)	144 (not noted)	FO -- *Crangon*, *P. affinis*, juvenile Atlantic rock crab, sand lance (*Ammodytes* sp.), and *D. leptocerus*.
Steimle (1994)	New York Bight apex	1986-89 (monthly)	1,047 (10-34, mostly >17)	FO -- *P. affinis*, *Crangon*, *D. leptocerus*, Atlantic rock crab, and *N. incisa*.
Rachlin and Warkentine (1988)	Central New Jersey	Unreported	133 (6-32, mostly subadults)	TN -- *Neomysis*, decapod crustaceans (*Crangon*), nematodes, copepods, amphipods, isopods, and fish.

Table 14. Summary of Hudson-Raritan Estuary weakfish diet by sampling period during 1996-97, expressed as the percent frequency of occurrence of dominant prey or items (FO), and as the mean percent contribution of dominant prey or items to total stomach content volume (TV). (n = sample size; ES = percent of empty stomachs.)

	Sampling Period											
	Jul 96 (n = 0; ES = N/A)		Oct 96 (n = 66; ES = 12)		Jan 97 (n = 0; ES = N/A)		Apr 97 (n = 0; ES = N/A)		Aug 97 (n = 117; ES = 3)		Nov 97 (n = 14; ES = 57)	
Prey	FO	TV	FO	TV	FO	TV	FO	TV	FO	TV	FO	TV
Crangon septemspinosa	-	-	63.6	20.5	-	-	-	-	54.7	30.0	14.3	23.9
Neomysis americana	-	-	31.8	3.3	-	-	-	-	81.3	26.7	14.3	4.5
Unidentified fish (*Anchoa*?)	-	-	24.2	3.8	-	-	-	-	21.4	12.5	7.1	15.9
Gammarus lawrencianus	-	-	27.3	4.3	-	-	-	-	0.9	0.9	14.3	11.4
Unidentified organic matter	-	-	10.6	0.5	-	-	-	-	1.7	0.9	7.1	1.1
Anchoa mitchilli	-	-	13.5	17.3	-	-	-	-	1.9	<0.1	0.0	0.0
Ampelisca abdita	-	-	0.0	0.0	-	-	-	-	1.7	<0.1	7.1	3.4
Juvenile silver hake	-	-	0.0	0.0	-	-	-	-	0.0	0.0	7.1	36.4

Table 15. Summary of other weakfish diet studies for the coastal Middle Atlantic Bight. (Major prey taxa ranked in relative order of importance by: mean percent frequency of occurrence (FO), mean percent contribution to total stomach content volume (TV), and mean percent contribution to total stomach content weight (TW), as available from each source.)

Source	Study Area	Year(s) (month(s), season(s), and/or frequency)	No. Examined (size [TL cm]) or age range, mean size)	Primary Prey in Order of Importance by FO, IRI, TDW, TN, TV, and/or TW
Welsh and Breder (1924)	Acushnet River, MA	1882 (Sep)	28 (7-11)	TV -- Fish (killifish and river herring) and "shrimp."
Peck (1896)	Woods Hole, MA	1893 (summer)	570 ("older fish")	FO -- Juvenile herring and bluefish, butterfish, herring, squid, crustaceans, and juvenile Atlantic menhaden.
Welsh and Breder (1924)	Cape May, NJ	1916 (Aug)	32 (3-8)	TV -- Mysids, "shrimp," unidentified crustaceans, and juvenile herring.
		1919 (May)	30 (24-39)	TV -- Mysids, unidentified crustaceans, and "shrimp."
Welsh and Breder (1924)	Cape Charles, VA	1916 (Sep)	45 (4-12)	TV -- Mysids, copepods, amphipods, and juvenile herring.
Breder (1922b)	Raritan Bay, NJ	1921 (summer)	? (33-51)	FO? -- Squid, shrimp, juvenile Atlantic menhaden, silver perch, and anchovy.
Tressler and Bere (1939)	Southern Long Island, NY	1938 (summer)	89 (4-11)	FO? -- *Crangon* and copepods.

Shuster (1959)	Delaware Bay	1952 (summer/fall)	205 (12-30)	FO -- *Neomysis*, unidentified fish, *Solen viridis*, and *Crangon*
Richards (1963)	Long Island Sound	1956-57 (seasonally)	Sand station - 23 (4-10)	FO? -- *Crangon*, *Upogebia* sp., juvenile bay anchovy, copepods, and *Ampelisca* sp.
			Mud station - 48 (4-8)	FO? -- *Crangon*, *Neomysis*, and copepods.
de Sylva *et al.* (1962)	Delaware Bay	1958-60 (summer/fall)	220 (2-15)	FO -- *Neomysis*, *Crangon*, decapod larvae, juvenile *Limulus polyphemus*, and unidentified juvenile fish.
Van Engle and Joseph (1968)	Chesapeake Bay, VA	1967 (summer)	268 ("juveniles")	TV -- Unidentified fish (mostly bay anchovy and naked goby), *Neomysis*, *Crangon*, copepods, and amphipods. FO -- *Neomysis*, fish, copepods, and amphipods.
Thomas (1971)	Delaware River	1969 (summer/fall)	494 (5-18)	FO -- *Neomysis*, *Gammarus* sp., unidentified fish , juvenile weakfish, detritus, and copepods.
			64 (>18)	FO -- Juvenile weakfish, unidentified fish, *Neomysis*, and *Gammarus* sp.
Kimmel (1973)	Mouth of Chesapeake Bay	1971-72 (spring/summer)	27 (2-28)	TV -- *Neomysis*, calanoid copepods, *Crangon*, and unidentified crustaceans.
Festa (1979)	Little Egg Harbor, NJ	1972-77 (summer/fall)	51 (<17)	TV -- *Neomysis*, fish (anchovy), *Crangon*, and *Ampelisca* sp. FO -- *Neomysis*, *Crangon*, fish, and *Ampelisca* sp.
Chao and Musick (1977)	York River, VA	1973 (summer)	36 (7-18)	FO -- Bay anchovy, *Neomysis*, and other fish.
Allen *et al.* (1978)	Hereford Inlet, NJ	1973-77 (biweekly/ monthly)	86 (3-22)	FO -- Mysids, *Crangon*, crab larvae, and unidentified fish.
Bason *et al.* (1975, 1976); Keirsey *et al.* (1977)	Chesapeake and Delaware Canal, DE	1974-76 (summer/fall)	1,119 (2-44, mostly < 10)	TV -- *Neomysis*, bay anchovy, *Crangon*, *Gammarus* sp., juvenile fish (Atlantic menhaden, weakfish, and croaker), polychaetes, and *Corophium* sp.
Homer and Boynton (1978)	Chesapeake Bay, MD	1977 (summer)	808 (3-19)	TW -- Bay anchovy, *Pseudodiaptomus coronatus*, juvenile weakfish, *Nereis succinea*, and other polychaetes.
Scarlett and Giust (1989)	Manasquan River, NJ	1984-86 (monthly)	45 (9-20)	TV -- *Crangon*, sand lance, detritus, *Neomysis*, unidentified fish, and naked goby.
Hartman and Brandt (1995)	Chesapeake Bay	1990-92 (bimonthly?)	564 (age 0)	TW -- Juvenile bay anchovy and other fish (*e.g.* juvenile croaker).
			353 (age 1)	TW -- Bay anchovy, juvenile Atlantic menhaden, spot, and other fish.
			54 (age 2+)	TW -- Spot, Atlantic menhaden, juvenile summer flounder, and bay anchovy.

Table 16. Summary of Hudson-Raritan Estuary spotted hake diet by sampling period during 1996-97, expressed as the percent frequency of occurrence of dominant prey or items (FO), and as the mean percent contribution of dominant prey or items to total stomach content volume (TV). (n = sample size; ES = percent of empty stomachs.)

	Sampling Period											
	Jul 96 (n = 44; ES = 0)		Oct 96 (n = 14; ES = 7)		Jan 97 (n = 1; ES = 0)		Apr 97 (n = 72; ES = 0)		Aug 97 (n = 3; ES = 33)		Nov 97 (n = 28; ES = 0)	
Prey	FO	TV	FO	TV	FO	TV	FO	TV	FO	TV	FO	TV
Crangon septemspinosa	95.5	60.9	85.7	42.4	100.0	33.3	76.4	47.1	66.7	38.9	89.3	31.3
Neomysis americana	15.9	5.9	14.3	4.1	100.0	33.3	33.3	8.9	100.0	40.7	7.1	0.3
Unidentified juvenile fish	0.0	0.0	7.1	13.5	0.0	0.0	5.6	5.0	33.3	20.4	50.0	17.2
Unidentified organic matter	6.8	0.4	0.0	0.0	0.0	0.0	13.9	5.4	0.0	0.0	3.6	<0.1
Gammarus lawrencianus	15.9	4.4	28.6	9.3	0.0	0.0	0.0	0.0	0.0	0.0	17.9	4.3
Pseudodiaptomus sp.	0.0	0.0	0.0	0.0	100.0	33.3	13.9	2.1	0.0	0.0	10.7	0.1
Unidentified juvenile flounder	2.3	0.5	0.0	0.0	0.0	0.0	1.4	4.1	0.0	0.0	17.9	4.2
Juvenile *Anguilla rostrata*	0.0	0.0	7.1	13.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Unidentified hydroids	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.9	9.5

Table 17. Summary of other spotted hake diet studies for the coastal Middle Atlantic Bight. (Major prey taxa ranked in relative order of importance by: mean percent frequency of occurrence (FO), mean percent contribution to total stomach content volume (TV), mean percent contribution to total stomach content weight (TW), and mean percent contribution to total number of individual items in the stomach (TN), as available from each source.)

Source	Study Area	Year(s) (month(s), season(s), and/or frequency)	No. Examined (size [TL cm]) or age range, mean size)	Primary Prey in Order of Importance by FO, IRI, TDW, TN, TV, and/or TW
Linton, quoted in Hildebrand and Schroeder (1928)	Woods Hole, MA?	Unknown	141 (unknown)	FO? -- "*Mysis*," shrimp, crabs, amphipods, isopods, fish, polychaetes, leeches, sponges, and hydroids.
Richards (1963)	Long Island Sound	1955-57 (monthly)	Sand station - 17 (6-20) Mud station - 16 (5-19)	FO -- *Leptocheirus pinguis*, *Crangon*, and sand lance. FO -- Sand lance, *Corophium* sp., and copepods (Temora sp.).
Barans (1969)	Chesapeake Bay	1966-68 (Mar-Jul)	600 (5-18)	FO -- *Crangon*, other shrimp, *Neomysis*, squid, polychaetes, and unidentified fish.
Kimmel (1973)	Mouth of Chesapeake Bay	1971-72 (spring)	44 (3-20)	TV -- *Neomysis*, *Crangon*, *Ampelisca* sp., other crustaceans, and bay anchovy.

Festa (1979)	Little Egg Harbor, NJ	1972-77 (spring/fall)	16 (5-19)	TV -- *Crangon*, *Palaemonetes* sp., and *Neomysis*. FO -- *Crangon* and *Neomysis*.
Bowman *et al.* (1987)	Southern New England	1973-76 (spring/fall)	244 (YOY)	TW -- Euphausids, *Crangon*, and *Dichelopandalus leptocerus*.
Rachlin and Warkentine (1987)	Coastal New York Bight	1973-74 (summer)	156 (5-21)	TN -- *Neomysis*, copepods (*Acartia* sp. and *Temora* sp.), *Crangon*, amphipods (*Gammarus* sp.), round herring (*Etrumeus teres*), and decapod crustacean larvae.
Allen *et al.* (1978)	Hereford Inlet, NJ	1973-77 (biweekly/ monthly)	101 (5-17)	FO -- *Crangon*, mysids, detritus, and copepods.
Sedberry (1983)	New York Bight shelf	1976-77 (seasonally)	129 (< 20)	TV -- Atlantic rock crab, *D. leptocerus*, *Crangon*, unidentified hake, Gulf Stream flounder (*Citharichthys arctifrons*), and amphipods.
			68 (>20)	TV -- As above, plus squid and juvenile sea scallops.
Homer and Boynton (1978)	Chesapeake Bay, MD	1977 (spring)	19 (10-15)	TW -- *Crangon*, juvenile Atlantic menhaden, *Nereis succinea*, bay anchovy, and juvenile spot.

Table 18. Summary of Hudson-Raritan Estuary striped searobin diet by sampling period during 1996-97, expressed as the percent frequency of occurrence of dominant prey or items (FO), and as the mean percent contribution of dominant prey or items to total stomach content volume (TV). (n = sample size; ES = percent of empty stomachs.)

	Sampling Period											
	Jul 96 (n = 26; ES = 4)		Oct 96 (n = 39; ES = 11)		Jan 97 (n = 0; ES = N/A)		Apr 97 (n = 5; ES = 40)		Aug 97 (n = 81; ES = 5)		Nov 97 (n = 2; ES = 0)	
Prey	FO	TV	FO	TV	FO	TV	FO	TV	FO	TV	FO	TV
Crangon septemspinosa	96.2	56.2	74.4	42.3	-	-	60.0	71.1	75.3	37.4	50.0	71.4
Neomysis americana	23.1	12.8	25.6	9.5	-	-	0.0	0.0	37.0	10.2	0.0	0.0
Unidentified organic matter	0.0	0.0	15.4	8.6	-	-	0.0	0.0	6.2	0.7	0.0	0.0
Juvenile Atlantic rock crab	3.8	2.7	7.7	9.0	-	-	0.0	0.0	11.1	9.7	0.0	0.0
Coal pebbles	3.8	0.7	2.6	<0.1	-	-	0.0	0.0	4.9	1.6	0.0	0.0
Juvenile *Ovalipes ocellatus*	0.0	0.0	5.1	8.1	-	-	0.0	0.0	9.9	5.4	0.0	0.0
Unidentified juvenile fish	3.8	7.7	2.6	0.9	-	-	0.0	0.0	11.1	5.8	0.0	0.0
Juvenile striped searobin	0.0	0.0	0.0	0.0	-	-	0.0	0.0	7.4	8.8	0.0	0.0
Ampelisca abdita	7.7	1.3	0.0	0.0	-	-	0.0	0.0	2.4	0.1	0.0	0.0
Gammarus lawrencianus	3.8	0.7	15.4	7.4	-	-	0.0	0.0	0.0	0.0	0.0	0.0

Table 19. Summary of other striped searobin diet studies for the coastal Middle Atlantic Bight. (Major prey taxa ranked in relative order of importance by: mean percent frequency of occurrence (FO), mean percent contribution to total stomach content volume (TV), mean percent contribution to total stomach content weight (TW), and mean percent contribution to total number of individual items in the stomach (TN), as available from each source.)

Source	Study Area	Year(s) (month(s), season(s), and/or frequency)	No. Examined (size [TL cm]) or age range, mean size)	Primary Prey in Order of Importance by FO, IRI, TDW, TN, TV, and/or TW
Marshall (1946)	New Haven, CT	1942 (summer)	28 (YOY)	FO -- *Crangon* and unidentified fish.
Marshall (1946)	Woods Hole, MA	1943-44 (summer)	10 (3-6) 11 (18-30)	FO -- *Crangon*, copepods, and eggs. FO -- *Neomysis*, *Gammarus* sp., *Crangon*, and fish (northern searobin, unidentified flounder, and others).
Kimmel (1973)	Mouth of Chesapeake Bay	1971-72 (spring/summer)	7 (10-14)	TV -- *Neomysis* and *Crangon*.

Richards *et al.* (1979)	Long Island Sound, CT	1971-72 (spring/fall)	124 (4-14)	TN -- *Neomysis*, copepods (*Temora* sp. and *Labidocera* sp.), and *Crangon*.
		1976-77 (same)	57 (12-33)	TN -- *Crangon* and *Neomysis*.
Mann (1974)	Long Island Sound, NY	1973 (spring-fall)	533 (YOY) 390 (1-9)	TN -- *Neomysis* and *Crangon*. TN -- Crabs, *Crangon*, juvenile fish (scup, northern and striped searobins, windowpane, winter flounder, bay anchovy, *Menidia*, and northern pipefish), and *Neomysis*.
Carlson (1991)	New Haven Harbor, CT	1989-90 (monthly)	15 (32-39)	TW -- *Ovalipes ocellatus*, juvenile winter flounder, and juvenile Atlantic rock crab. FO -- *O. ocellatus*, Atlantic rock crab, and juvenile winter flounder.
Manderson *et al.* (1999)	Sandy Hook Bay, NJ	1998 (Jun-Oct)	77 (18-37, mean = 28)	TW -- *Crangon*, mysids (*Neomysis*), juvenile winter flounder, amphipods, and juvenile *O. ocellatus*. FO -- *Crangon*, mysids, juvenile winter flounder, amphipods, and *O. ocellatus*.

Table 20. Summary of Hudson-Raritan Estuary northern searobin diet by sampling period during 1996-97, expressed as the percent frequency of occurrence of dominant prey or items (FO), and as the mean percent contribution of dominant prey or items to total stomach content volume (TV). (n = sample size; ES = percent of empty stomachs.)

	Sampling Period											
	Jul 96 (n = 0; ES = N/A)		Oct 96 (n = 2; ES = 0)		Jan 97 (n = 0; ES = N/A)		Apr 97 (n = 10; ES = 40)		Aug 97 (n = 87; ES = 5)		Nov 97 (n = 4; ES = 0)	
Prey	FO	TV	FO	TV	FO	TV	FO	TV	FO	TV	FO	TV
Crangon septemspinosa	-	-	50.0	16.7	-	-	10.0	16.7	77.0	37.0	50.0	33.3
Neomysis americana	-	-	100.0	33.3	-	-	10.0	16.7	16.1	4.0	50.0	16.7
Gammarus lawrencianus	-	-	100.0	33.3	-	-	0.0	0.0	5.7	3.6	25.0	8.3
Unidentified crustaceans	-	-	0.0	0.0	-	-	30.0	25.0	1.1	0.1	0.0	0.0
Juvenile Atlantic rock crab	-	-	0.0	0.0	-	-	0.0	0.0	37.9	23.6	0.0	0.0
Unciola sp.	-	-	50.0	16.7	-	-	0.0	0.0	2.3	1.0	0.0	0.0
Juvenile *Ovalipes ocellatus*	-	-	0.0	0.0	-	-	0.0	0.0	9.2	6.2	0.0	0.0
Unidentified amphipods	-	-	0.0	0.0	-	-	0.0	0.0	2.3	0.5	25.0	8.3
Unidentified juvenile fish	-	-	0.0	0.0	-	-	0.0	0.0	4.6	1.6	25.0	25.0
Coal pebbles	-	-	0.0	0.0	-	-	0.0	0.0	24.1	6.8	0.0	0.0

Table 21. Summary of other northern searobin diet studies for the coastal Middle Atlantic Bight. (Major prey taxa ranked in relative order of importance by: mean percent frequency of occurrence (FO), mean percent contribution to total stomach content volume (TV), mean percent contribution to total stomach content weight (TW), and mean percent contribution to total number of individual items in the stomach (TN), as available from each source.)

Source	Study Area	Year(s) (month(s), season(s), and/or frequency)	No. Examined (size [TL cm]) or age range, mean size)	Primary Prey in Order of Importance by FO, IRI, TDW, TN, TV, and/or TW
Linton (1901)	Woods Hole, MA	1899-1900 (summer)	Unknown	FO? -- Herring, softshells, *Palaemonetes* sp., amphipods, squid, "clams," polychaetes, and juvenile winter flounder.
Marshall (1946)	Woods Hole , MA	1943 (summer)	42 (2-7)	FO -- Amphipods (*Gammarus locusta*), *Crangon*, copepods, and *Neomysis*.
			38 (>13)	FO -- *Crangon*, *G. locusta*, *Neomysis*, *Ampelisca* sp., and polychaetes.
Marshall (1946)	Block Island Sound	1943 (summer)	13 (>17)	FO -- *Ampelisca* sp., *G. locusta*, *Unciola irrorata*, *Cerapus tubularis*, and polychaetes.

Marshall (1946)	Montauk Point, NY	1943 (spring)	12 (18-25)	FO -- *Monoculodes edwardsi*, *Neomysis*, cumaceans, and *Crangon*.
Smith (1950)	Block Island Sound	1948-49 (seasonally)	Unknown	TV? -- *Leptocheirus pinguis*, *U. irrorata*, and *Crangon*.
Richards (1963)	Long Island Sound	1956-57 (seasonally)	Sand station - 103 (2-16)	FO? -- Copepods, amphipods, *Neomysis*, *Heteromysis formosa*, *Pagurus* sp., *Crangon*, bay anchovy, and *Cyathura* sp.
			Mud station - 23 (2-10)	FO? -- Copepods, amphipods (*Unciola* sp.), *Neomysis*, and cumaceans.
Kimmel (1973)	Mouth of Chesapeake Bay	1971-72 (spring-summer)	47 (2-12)	TV -- *Neomysis*, *Crangon*, and *A. macrocephala*.
Richards *et al.* (1979)	Long Island Sound	1971-73 (spring-fall)	120 (4-12)	TN -- *Neomysis*, copepods (*Acartia* sp., *Pseudodiaptomus coronatus*, and *Temora* sp.), and *Crangon*.
		1976-77	25 (10-30)	TN -- Amphipods, isopods, crabs, *Crangon*, and *Neomysis*.
Mann (1974)	Long Island Sound, NY	1973 (May-Dec)	419 (~10-29)	TN -- *Crangon*, crabs, bivalve mollusks (*Ensis directus*), amphipods (*Unciola* sp.), isopods, cumaceans, and copepods.
Allen *et al.* (1978)	Hereford Inlet, NJ	1973-77 (biweekly/ monthly)	107 (4-21)	FO -- Amphipods, *Crangon*, mysids, crabs, unidentified fish, polychaetes, crab larvae, and *Pagurus* sp.
Homer and Boynton (1978)	Chesapeake Bay, MD	1977 (May/Sep)	Unknown (~5-18)	TW -- Juvenile weakfish, *Nereis succinea*, amphipods, polychaetes, and anemones.

Table 22. Summary of Hudson-Raritan Estuary striped bass diet by sampling period during 1996-97, expressed as the percent frequency of occurrence of dominant prey or items (FO), and as the mean percent contribution of dominant prey or items to total stomach content volume (TV). (n = sample size; ES = percent of empty stomachs.)

	Sampling Period											
	Jul 96 (n = 0; ES = N/A)		Oct 96 (n = 3; ES = 100)		Jan 97 (n = 24; ES = 37)		Apr 97 (n = 32; ES = 25)		Aug 97 (n = 0; ES = N/A)		Nov 97 (n = 22; ES = 9)	
Prey	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**
Crangon septemspinosa	-	-	0.0	0.0	58.3	100.0	75.9	36.9	-	-	54.5	15.0
Neomysis americana	-	-	0.0	0.0	0.0	0.0	31.0	16.6	-	-	4.5	<0.1
Unidentified fish remains	-	-	0.0	0.0	0.0	0.0	3.4	0.3	-	-	36.4	1.9
Smallmouth flounder	-	-	0.0	0.0	0.0	0.0	0.0	0.0	-	-	18.2	12.3
Palaemonetes sp.	-	-	0.0	0.0	0.0	0.0	0.0	0.0	-	-	13.6	5.1
Ampelisca abdita	-	-	0.0	0.0	0.0	0.0	17.2	6.6	-	-	0.0	0.0
Juvenile red hake	-	-	0.0	0.0	0.0	0.0	0.0	0.0	-	-	13.6	10.6
Unidentified goby	-	-	0.0	0.0	0.0	0.0	0.0	0.0	-	-	9.1	0.8
Juvenile silver hake	-	-	0.0	0.0	0.0	0.0	0.0	0.0	-	-	13.6	3.4
Juvenile *Ovalipes ocellatus*	-	-	0.0	0.0	0.0	0.0	0.0	0.0	-	-	13.6	4.2
Nassarius trivittatus	-	-	0.0	0.0	0.0	0.0	3.4	2.9	-	-	4.5	5.9
Northern searobin	-	-	0.0	0.0	0.0	0.0	3.4	2.4	-	-	4.5	5.9

Table 23. Summary of other striped bass diet studies for the coastal Middle Atlantic Bight. (Major prey taxa ranked in relative order of importance by: mean percent frequency of occurrence (FO), mean percent contribution to total stomach content volume (TV), mean percent contribution to total stomach content weight (TW), and mean percent contribution to total number of individual items in the stomach (TN), as available from each source.)

Source	Study Area	Year(s) (month(s), season(s), and/or frequency)	No. Examined (size [TL cm]) or age range, mean size)	Primary Prey in Order of Importance by FO, IRI, TDW, TN, TV, and/or TW
Curran and Reis (1937)	Lower Hudson River, NY	1936 (unknown)	Unknown ("small")	FO? -- *Gammarus fasciatus*, chironomids, and copepods.
Merriman (1941)	Connecticut coast	1936-37 (Apr-Nov)	550 ("juveniles")	FO? -- *Menidia* and juvenile Atlantic menhaden.
Hollis (1952)	Chesapeake Bay	1936-37 (seasonally)	1,736 (~14-74)	TN -- Bay anchovy, Atlantic menhaden, spot, croaker, herring, unidentified fish, cladocerans, isopods, *Crangon*, and *Palaemonetes* sp.
de Sylva *et al.* (1962)	Delaware Bay	1958-60 (Mar-Dec)	279 (4-31)	FO -- *Neomysis*, *Gammarus* sp., *Crangon*, *Palaemonetes* sp., other crustaceans, *Limulus polyphemus* eggs and larvae, and unidentified fish.

Schaefer (1970)	Southern Long Island surf zone	1964 (Apr-Nov)	61 (28-40)	TV -- Amphipods (*Gammarus* sp. and haustorids), *Neomysis*, Atlantic surfclam, and bay anchovy.
			183 (41-60)	TV -- Amphipods (*Gammarus* sp. and haustorids), bay anchovy, *Menidia*, and scup.
			123 (61-94)	TV -- Amphipods (*Gammarus* sp. and haustorids), red hake, *Ovalipes ocellatus*, scup, bay anchovy, juvenile tautog, northern puffer, and mullet.
Markle and Grant (1970)	York River, VA	1967 (Jul-Oct)	297 (3-15)	TV -- Fish (goby, *Menidia*, and shiners), *Palaemonetes* sp., Crangon, *Neomysis*, and polychaetes.
Festa (1979)	Little Egg Harbor, NJ	1972-77 (fall)	11 (43-58)	TV -- Sand lance, weakfish, unidentified fish, and *Crangon*. FO -- Sand lance, unidentified fish, and *Crangon*.
Gardinier and Hoff (1982)	Middle Hudson River Estuary	1974 (Apr-Nov)	546 (<15)	FO -- *Gammarus* sp., calanoid copepods, and juvenile fish (Atlantic tomcod).
			(15-28)	FO -- Fish (herring, Atlantic tomcod, bay anchovy, banded killifish, and mummichog).
		1976-77 (Apr-May)	380 (>20)	FO -- Fish (herring, bay anchovy, shiners, and killifish), detritus, and "invertebrates."
Boynton *et al.* (1981)	Potomac River, VA/MD	1976 (biweekly, Jun-Sep, higher salinity area)	703 (2.5-10)	TN -- Fish, mysids, and polychaetes.
Homer and Boynton (1978)	Chesapeake Bay, MD	1977 (spring)	19 (10-15)	TW -- *Crangon*, juvenile Atlantic menhaden, *Nereis succinea*, bay anchovy, and juvenile spot.
Lawler, Matusky & Skelly Engineers (1980)	Hudson River, NY	1979-80 (seasonally)	239 (mean = 18.50)	TV -- *Gammarus* sp., *Crangon*, *Paleomonetes* sp., and *Neomysis*.
Fay *et al.* (1982)	Hudson River	Unknown	(<7.5) (7.6-12.5) (13-20)	FO? -- *Gammarus* sp., calanoid copepods, and insect larva. FO? -- *Gammarus* sp. and calanoid copepods. FO? -- Atlantic tomcod.
Fay *et al.* (1982)	Delaware River	Unknown	(5-10)	FO? -- *Neomysis* and *Crangon*.
Fay *et al.* (1982)	Chesapeake Bay	Unknown	(7-15) (10-27)	FO? -- Naked goby and *Palaemonetes* sp. FO? -- Bay anchovy.
Hartman and Brandt (1995)	Chesapeake Bay	1990-92 (bimonthly)	(age 0) (age 1)	TW -- Juvenile Atlantic menhaden, spot, and other fish. TW -- "Invertebrates," Atlantic menhaden, bay anchovy, and *Gammarus* sp.
			(age 2)	TW -- Atlantic menhaden, spot, and other fish.

Table 24. Summary of Hudson-Raritan Estuary clearnose skate diet by sampling period during 1996-97, expressed as the percent frequency of occurrence of dominant prey or items (FO), and as the mean percent contribution of dominant prey or items to total stomach content volume (TV). (n = sample size; ES = percent of empty stomachs.)

	Sampling Period											
	Jul 96 (n = 27; ES = 0)		**Oct 96 (n = 13; ES = 0)**		**Jan 97 (n = 0; ES = N/A)**		**Apr 97 (n = 0; ES = N/A)**		**Aug 97 (n = 30; ES = 0)**		**Nov 97 (n = 1; ES = 0)**	
Prey	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**
Crangon septemspinosa	78.8	25.1	61.5	29.2	-	-	-	-	36.7	15.1	100.0	33.3
Atlantic rock crab	60.6	37.2	7.7	1.9	-	-	-	-	73.4	25.7	0.0	0.0
Unidentified fish remains	9.1	2.3	46.2	17.7	-	-	-	-	20.0	10.1	100.0	33.3
Ovalipes ocellatus	6.1	2.5	15.4	9.8	-	-	-	-	13.3	7.6	100.0	33.3
Juvenile conger eel	0.0	0.0	15.4	11.3	-	-	-	-	0.0	0.0	0.0	0.0
Juvenile winter flounder	3.0	2.9	7.7	11.3	-	-	-	-	0.0	0.0	0.0	0.0
Unidentified juvenile flounder	0.0	0.0	0.0	0.0	-	-	-	-	23.3	13.3	0.0	0.0
Unidentified organic matter	6.1	1.7	23.1	6.8	-	-	-	-	3.3	<0.1	0.0	0.0
Xanthid crabs	12.1	6.4	0.0	0.0	-	-	-	-	6.7	2.2	0.0	0.0
Juvenile windowpane	6.1	4.7	0.0	0.0	-	-	-	-	3.3	1.7	0.0	0.0
Ensis directus	6.1	6.5	0.0	0.0	-	-	-	-	6.7	3.3	0.0	0.0

Table 25. Summary of other clearnose skate diet studies for the coastal Middle Atlantic Bight. (Major prey taxa ranked in relative order of importance by: mean percent frequency of occurrence (FO), and mean percent contribution to total stomach content volume (TV), as available from each source.)

Source	Study Area	Year(s) (month(s), season(s), and/or frequency)	No. Examined (size [TL cm]) or age range, mean size)	Primary Prey in Order of Importance by FO, IRI, TDW, TN, TV, and/or TW
Fitz and Daiber (1963)	Delaware Bay	1954-56 (seasonally)	363 (mean = 56)	FO -- *Crangon*, *Ensis directus*, xanthid crabs (*Dyspanopeus*), *Libinia dubia*, *Pagurus* sp., *Neomysis*, and fish (weakfish, windowpane, bay anchovy, and others).
Kimmel (1973)	Mouth of Chesapeake Bay	1971-72 (monthly)	28 (19-44)	TV -- *Crangon*, *E. directus*, *Solen* sp., *Upogebia* sp., *Neomysis*, and unidentified fish. FO — *Crangon*, *Neomysis*, unidentified fish, *Upogebia* sp., and *Neomysis*.
Steimle (unpubl. data)	Delaware Bay	1989-94 (May/Jun and Aug/Sep)	96 (28.0-78.0, mean = 58.0)	TV -- Atlantic rock crab, *E. directus*, unidentified fish and crustaceans, *Pagurus* sp., *Dyspanopeus sayi*, and *Crangon*.

Table 26. Summary of Hudson-Raritan Estuary bluefish diet by sampling period during 1996-97, expressed as the percent frequency of occurrence of dominant prey or items (FO), and as the mean percent contribution of dominant prey or items to total stomach content volume (TV). (n = sample size; ES = percent of empty stomachs.)

	Sampling Period											
	Jul 96 (n = 0; ES = N/A)		Oct 96 (n = 1; ES = 0)		Jan 97 (n = 0; ES = N/A)		Apr 97 (n = 0; ES = N/A)		Aug 97 (n = 62; ES = 0)		Nov 97 (n = 0; ES = N/A)	
Prey	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**
Unidentified fish remains	-	-	0.0	0.0	-	-	-	-	41.9	41.4	-	-
Crangon septemspinosa	-	-	0.0	0.0	-	-	-	-	24.2	22.2	-	-
Neomysis americana	-	-	0.0	0.0	-	-	-	-	21.0	17.3	-	-
Unidentified organic matter	-	-	0.0	0.0	-	-	-	-	9.7	3.7	-	-
Juvenile butterfish	-	-	0.0	0.0	-	-	-	-	1.6	9.3	-	-
Anchoa sp.	-	-	100.0	100.0	-	-	-	-	1.6	1.9	-	-

Table 27. Summary of other bluefish diet studies for the coastal Middle Atlantic Bight. (Major prey taxa ranked in relative order of importance by: mean percent frequency of occurrence (FO), mean percent contribution to total stomach content volume (TV), and mean percent contribution to total stomach content weight (TW), as available from each source.)

Source	Study Area	Year(s) (month(s), season(s), and/or frequency)	No. Examined (size [TL cm]) or age range, mean size)	Primary Prey in Order of Importance by FO, IRI, TDW, TN, TV, and/or TW
Peck (1896)	Woods Hole, MA	1893 (Jul-Aug)	38 (?)	FO -- Atlantic menhaden, butterfish, herring, squid, and YOY fish.
Breder (1922a)	Atlantic City, NJ	1920 (Aug)	31 (14-21)	TV -- Butterfish, juvenile spot, unidentified fish, and plant material.
Grant (1962)	Indian River, DE	1956-58 (summer)	262 (3-24)	TV -- Mummichog, juvenile Atlantic menhaden, *Menidia*, bay anchovy, and unidentified fish. FO -- Unidentified fish, juvenile Atlantic menhaden, *Menidia*, mummichog, and polychaetes.
de Sylva *et al.* (1962)	Delaware Bay shore	1958-60 (summer)	152 (4-23)	FO -- Unidentified fish, *Menidia*, *Neomysis*, *Crangon*, herring, and bay anchovy.

Festa (1979)	Little Egg Harbor, NJ	1972-77 (summer/fall)	16 (6-10)	TV -- *Palaemonetes* sp., unidentified fish, *Nereis* sp., *Nephtys* sp., and *Menidia*. FO -- Unidentified fish, crab larvae, and *Nereis* sp.
			62 (11-20)	TV -- Unidentified fish, mummichog, *Menidia*, juvenile blue crab, and bay anchovy. FO -- Unidentified fish, *Crangon*, detritus, bay anchovy, *Menidia*, and *Neomysis*.
Allen *et al.* (1978)	Hereford Inlet, NJ	1973-77 (biweekly/ monthly)	301 (3-18)	FO -- Unidentified fish, *Crangon*, *Menidia*, crab larvae, juvenile spot, and shrimp larvae.
Bason *et al.* (1976)	Chesapeake and Delaware Canal, DE	1975 (spring-summer)	201 (5-33)	TV -- Bay anchovy, juvenile Atlantic menhaden, juvenile weakfish, unidentified fish, *Menidia*, and juvenile bluefish.
Lynch *et al.* (1977)	Raritan River and Bay	1976-77 (Apr-Mar)	10 (3-22)	FO? -- Mummichog, bay anchovy, *Menidia*, *Crangon*, *Palaemonetes* sp., and fish.
			39 (39+)	FO? -- Atlantic menhaden, spot, bay anchovy, and *Crangon*.
Friedland *et al.* (1988)	Sandy Hook Bay, NJ	1981-84 (spring-summer)	1,079 (9-18)	TW -- Bay anchovy, *Crangon*, *Menidia*, *Neomysis*, striped killifish, and *Palaemonetes* sp. FO -- *Crangon*, *Neomysis*, bay anchovy, *Menidia*, *Palaemonetes* sp., and striped killifish.
Scarlett and Giust (1989)	Manasquan River, NJ	1984-86 (summer)	211 (9-29, mean =~15)	TV -- Bay anchovy, *Menidia*, *Crangon*, unidentified fish, *Gammarus* sp., and juvenile weakfish.
Juanes *et al.* (1993)	Hudson River, NY	1989 (Jul-Oct)	374 (YOY)	TW -- Atlantic tomcod, unidentified fish, juvenile striped bass, juvenile bluefish, and bay anchovy.
Juanes and Conover (1994)	Great South Bay, NY	1989 (Jun-Jul)	256 (YOY)	TW (Jun) -- *Menidia*, "shrimp," other fish, and bay anchovy. TW (Jul) -- bay anchovy, crustaceans, other fish, and *Menidia*.
Hartman and Brandt (1995)	Chesapeake Bay	1990-92 (bimonthly)	100 (age 0)	TW -- Bay anchovy, juvenile Atlantic menhaden, *Menidia*.
			132 (age 1)	TW -- Spot, juvenile Atlantic menhaden, and other fish.

Table 28. Summary of Hudson-Raritan Estuary winter skate diet by sampling period during 1996-97, expressed as the percent frequency of occurrence of dominant prey or items (FO), and as the mean percent contribution of dominant prey or items to total stomach content volume (TV). (n = sample size; ES = percent of empty stomachs.)

	Sampling Period											
	Jul 96 (n = 0; ES = N/A)		**Oct 96 (n = 5; ES = 20)**		**Jan 97 (n = 19; ES = 0)**		**Apr 97 (n = 24; ES = 0)**		**Aug 97 (n = 0; ES = N/A)**		**Nov 97 (n = 9; ES = 0)**	
Prey	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**
Crangon septemspinosa	-	-	40.0	14.9	100.0	44.8	95.8	42.7	-	-	77.8	28.2
Unidentified fish remains	-	-	20.0	9.0	15.8	5.6	4.2	1.2	-	-	22.2	9.8
Unidentified flounder	-	-	20.0	7.5	5.3	1.1	8.3	5.0	-	-	11.1	3.3
Atlantic rock crab	-	-	40.0	11.9	36.8	25.0	8.3	2.7	-	-	0.0	0.0
Blue mussel	-	-	20.0	4.5	0.0	0.0	4.1	1.3	-	-	11.1	3.6
Juvenile winter flounder	-	-	0.0	0.0	10.5	4.5	4.1	1.3	-	-	33.3	14.9
Ovalipes ocellatus	-	-	40.0	16.4	0.0	0.0	8.3	3.8	-	-	11.1	3.9
Sand lance	-	-	60.0	19.4	0.0	0.0	0.0	0.0	-	-	33.3	12.8

Table 29. Summary of other winter skate diet studies for the coastal Middle Atlantic Bight. (Major prey taxa ranked in relative order of importance by: mean percent contribution to total stomach content weight (TW), and an index of relative importance (IRI), as available from each source.)

Source	Study Area	Year(s) (month(s), season(s), and/or frequency)	No. Examined (size [TL cm]) or age range, mean size)	Primary Prey in Order of Importance by FO, IRI, TDW, TN, TV, and/or TW
Smith (1950)	Block Island Sound	1848-49 (seasonally)	Unknown (?)	TW -- "Nekton" (fish and squid), *Leptocheirus pinguis*, and *Nephtys incisa.*
Vinogradov (1984)	Southern New England	1968-74 (various)	52 (unknown)	TW -- Crustaceans, polychaetes, and fish.
McEachlan *et al.* (1976)	Middle Atlantic Bight shelf	1969-70 (seasonally)	441 (mode = ~60)	IRI -- Amphipods (*L. pinguis*), polychaetes (*N. incisa*, *Nereis* sp., *Pectinaria gouldii*, and maldanids), fish (sand lance), and decapod crustaceans (*Crangon*).

Table 30. Summary of Hudson-Raritan Estuary black sea bass diet by sampling period during 1996-97, expressed as the percent frequency of occurrence of dominant prey or items (FO), and as the mean percent contribution of dominant prey or items to total stomach content volume (TV). (n = sample size; ES = percent of empty stomachs.)

	Sampling Period											
	Jul 96 (n = 1; ES = 0)		Oct 96 (n = 3; ES = 0)		Jan 97 (n = 0; ES = N/A)		Apr 97 (n = 3; ES = 33)		Aug 97 (n = 46; ES = 11)		Nov 97 (n = 2; ES = 0)	
Prey	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**
Crangon septemspinosa	100.0	100.0	66.7	50.0	-	-	0.0	0.0	43.5	24.0	0.0	0.0
Neomysis americana	0.0	0.0	0.0	0.0	-	-	33.3	50.0	26.1	13.9	50.0	12.5
Juvenile Atlantic rock crab	0.0	0.0	33.3	2.9	-	-	0.0	0.0	17.4	16.8	0.0	0.0
Unidentified crustaceans	0.0	0.0	0.0	0.0	-	-	33.3	50.0	4.3	3.2	0.0	0.0
Corophium sp.	0.0	0.0	33.3	47.1	-	-	0.0	0.0	2.2	0.1	50.0	12.5
Xanthid crabs	0.0	0.0	0.0	0.0	-	-	0.0	0.0	8.7	10.3	0.0	0.0
Ampelisca abdita	0.0	0.0	0.0	0.0	-	-	0.0	0.0	15.2	1.0	0.0	0.0
Juvenile Atlantic menhaden	0.0	0.0	0.0	0.0	-	-	0.0	0.0	0.0	0.0	50.0	75.0
Unidentified organic matter	0.0	0.0	0.0	0.0	-	-	0.0	0.0	21.7	3.5	0.0	0.0

Table 31. Summary of other juvenile black sea bass diet studies for the coastal Middle Atlantic Bight. (Major prey taxa ranked in relative order of importance by: mean percent frequency of occurrence (FO), and mean percent contribution to total stomach content volume (TV), as available from each source.) [Note: there are other studies of the diet of black sea bass, but they were not included in this table because they were concerned with larger fish (*e.g.*, Steimle and Figley 1996), or because the size or life stage discussed was ambiguous, or because only a small sample (*e.g.*, less than 10 fish) was examined (*e.g.*, Steimle and Ogren 1982).]

Source	Study Area	Year(s) (month(s), season(s), and/or frequency)	No. Examined (size [TL cm]) or age range, mean size)	Primary Prey in Order of Importance by FO, IRI, TDW, TN, TV, and/or TW
Peck (1896)	Woods Hole, MA	1893 (Jul-Aug)	40 (unknown)	FO -- *Carcinus maenas*, *Ovalipes ocellatus*, amphipods, small fish (mostly sculpins), gastropods, American lobster, and *Pagurus* sp.
Richards (1963)	Long Island Sound - sand station	1956-58 (Sep-Oct)	28 (2-4)	FO? -- Caprellid amphipods, other amphipods (*Stenothoe* sp., *Corophium* sp., and *Ericthonius* sp.), hydroids, copepods, mysids, and *Pagurus* sp.
Kimmel (1973)	Mouth of Chesapeake Bay	1971-72 (spring/ summer)	48 (3-15)	TV -- *Neomysis*, unidentified polychaetes, xanthid (mud) crabs, and amphipods.

Allen *et al.* (1978)	Hereford Inlet, NJ	1973-77 (biweekly/ monthly)	201 (4-20)	FO -- Mysids, *Crangon*, detritus, amphipods, crabs, polychaetes, and unidentified fish.
Chee (1977)	Coastal Virginia	1975-76 (monthly)	26 (<15)	TV -- *Pagurus* sp., *O. ocellatus*, and Atlantic rock crab.
Festa (1979)	Little Egg Harbor, NJ	1976 (summer)	17 (6-21)	TV -- Mud crabs (*Neopanope* sp.), *O. ocellatus*, blue crab, *Palaemonetes* sp., and *Crangon*. FO -- Mud crabs, *Crangon*, isopod (*Idotea* sp.), amphipods (*Elasmopus* sp. and *Ampelisca* sp.), *Palaemonetes* sp., blue crab, and *Neomysis*.
Steimle (unpubl. data)	Delaware Bay	1989-94 (May/Jun and Aug/Sep)	185 (11.0-39.0, mean =24.0)	TV -- *Dyspanopeus sayi*, Atlantic rock crab, *Neomysis*, blue mussel, *Pagurus* sp., *Crangon*, and *Ensis directus*. FO -- *Neomysis*, Atlantic rock crab, *Dyspanopeus sayi*, blue mussel, and *Pagurus* sp.

Table 32. Summary of Hudson-Raritan Estuary spot diet by sampling period during 1996-97, expressed as the percent frequency of occurrence of dominant prey or items (FO), and as the mean percent contribution of dominant prey or items to total stomach content volume (TV). (n = sample size; ES = percent of empty stomachs.)

	Sampling Period											
	Jul 96 (n = 0; ES = N/A)		Oct 96 (n = 40; ES = 43)		Jan 97 (n = 6; ES = 83)		Apr 97 (n = 0; ES = N/A)		Aug 97 (n = 1; ES = 0)		Nov 97 (n = 0; ES = N/A)	
Prey	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**
Ampelisca abdita	-	-	30.0	24.2	0.0	0.0	-	-	100.0	50.0	-	-
Unidentified organic matter	-	-	32.5	8.2	0.0	0.0	-	-	0.0	0.0	-	-
Neomysis americana	-	-	17.5	11.5	16.7	100.0	-	-	0.0	0.0	-	-
Crangon septemspinosa	-	-	20.0	11.5	0.0	0.0	-	-	0.0	0.0	-	-
Unidentified copepods	-	-	0.0	0.0	0.0	0.0	-	-	100.0	50.0	-	-
Pseudodiaptomus sp.	-	-	12.5	18.6	0.0	0.0	-	-	0.0	0.0	-	-

Table 33. Summary of other spot diet studies for the coastal Middle Atlantic Bight. (Major prey taxa ranked in relative order of importance by: mean percent frequency of occurrence (FO), mean percent contribution to total stomach content volume (TV), and mean percent contribution to total stomach content weight (TW), as available from each source.)

Source	Study Area	Year(s) (month(s), season(s), and/or frequency)	No. Examined (size [TL cm]) or age range, mean size)	Primary Prey in Order of Importance by FO, IRI, TDW, TN, TV, and/or TW
Van Engle and Joseph (1968)	York River, VA	Unknown	162 (juveniles)	TV -- Polychaetes, amphipods, clam siphons, and cumaceans. FO -- Harpacticoid copepods, *Gammarus* sp., nematodes, cumaceans, polychaetes, and *Neomysis*.
Thomas (1971)	Delaware River	1970 (Oct)	17 (unknown)	FO -- Copepods, *Gammarus* sp., *Monoculodes* sp., ostracods, detritus, and *Neomysis*.
Kimmel (1973)	Mouth of Chesapeake Bay	1971-72 (spring/summer)	13 (YOY, <10) 35 (10-16)	TV -- Detritus and harpacticoid and calanoid copepods. TV -- Detritus, *Ampelisca macrocephalus*, harpacticoid copepods, and *Nereis*.
Festa (1978)	Little Egg Harbor, NJ	1972-77 (summer/fall)	48 (3-10) 44 (11-19)	TV -- Copepods and *Ampelisca* sp. FO -- Copepods and amphipods. TV -- Polychaetes, amphipods, copepods, and *Neomysis*. FO -- Copepods, detritus, polychaetes, and *Ampelisca* sp.

Chao and Musick (1977)	York River, VA	1973 (summer)	77 (7-20)	FO -- *Pectinaria gouldii*, *Glycinde solitaria*, nematodes, *Neomysis*, *Nereis succinea*, clams, detritus, copepods, and cumaceans.
Allen *et al.* (1978)	Hereford Inlet, NJ	1973-77 (biweekly/ monthly)	722 (2-17)	FO -- Copepods, polychaetes, amphipods, detritus, isopods, and mysids.
Homer and Boynton (1978)	Chesapeake Bay, MD	1977 (May-Dec)	1,400 (~2-15)	TW -- *N. succinea*, *Scolecolepides viridis*, *Paraprionospio pinnata*, *Eteone* sp., juvenile *Macoma* sp., and softshells.
Scarlett and Giust (1989)	Manasquan River, NJ	1984-85 (summer)	8 (17-18)	TV -- Detritus, *Crangon*, *Neomysis*, and *Ampelisca* sp.
Pihl *et al.* (1992)	York River, VA	1989 (Jun-Sep)	649 (5-20)	TW -- Polychaetes (esp. *P. pinnata*), amphipods, and mysids.
Timmons (1995)	Indian River, DE	1994 (July)	20 (mean = 9)	TV -- Detritus, polychaetes, and mysids.

Table 34. Summary of Hudson-Raritan Estuary American lobster diet by sampling period during 1996-97, expressed as the percent frequency of occurrence of dominant prey or items (FO), and as the mean percent contribution of dominant prey or items to total stomach content volume (TV). (n = sample size; ES = percent of empty stomachs.)

	Sampling Period											
	Jul 96 (n = 0; ES = N/A)		**Oct 96 (n = 6; ES = 0)**		**Jan 97 (n = 6; ES = 0)**		**Apr 97 (n = 10; ES = 0)**		**Aug 97 (n = 13; ES = 0)**		**Nov 97 (n = 12; ES = 0)**	
Prey	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**
Atlantic rock crab	-	-	0.0	0.0	67.7	16.7	50.0	14.9	42.1	18.4	41.6	18.3
Nucula sp.	-	-	0.0	0.0	50.0	15.2	30.0	13.0	30.8	7.0	16.7	0.4
Pagurus sp.	-	-	16.7	4.7	16.7	8.7	10.0	1.3	38.5	13.2	33.3	3.3
Human artifacts	-	-	16.7	4.8	16.7	3.6	20.0	1.9	0.0	0.0	16.7	0.4
Shell hash	-	-	50.0	23.8	16.7	3.6	10.0	0.6	15.4	4.4	0.0	0.0
Ovalipes ocellatus	-	-	50.0	23.8	0.0	0.0	0.0	0.0	0.0	0.0	8.3	1.7
Crangon septemspinosa	-	-	0.0	0.0	33.3	10.1	20.0	12.3	38.5	15.5	8.3	0.3
Unidentified hydroids	-	-	16.7	4.8	33.3	9.4	10.0	1.3	7.7	0.3	8.3	5.7
Sand	-	-	16.7	4.8	0.0	0.0	0.0	0.0	38.5	7.9	83.3	15.6
Unidentified organic matter	-	-	16.7	4.8	66.7	15.9	40.0	11.7	15.4	6.4	0.0	0.0
Unidentified crab fragments	-	-	0.0	0.0	16.7	3.6	40.0	11.7	7.7	0.9	8.3	0.1
Unidentified fish remains	-	-	0.0	0.0	16.7	5.8	20.0	7.8	23.1	6.7	0.0	0.0
Blue mussel	-	-	0.0	0.0	0.0	0.0	10.0	3.9	7.7	3.5	16.7	6.4
Skate egg case fragments	-	-	0.0	0.0	0.0	0.0	20.0	9.7	0.0	0.0	8.3	4.7
Hair and fibers	-	-	0.0	0.0	16.7	1.4	0.0	0.0	46.2	5.0	0.0	0.0
Xanthid crabs	-	-	0.0	0.0	0.0	0.0	0.0	0.0	7.7	3.5	66.7	10.2

Table 35. Summary of other American lobster diet studies for the coastal Middle Atlantic Bight. (Major prey taxa ranked in relative order of importance by mean percent frequency of occurrence (FO). Size is carapace length (CL), based on eye socket.)

Source	Study Area	Year(s) (month(s), season(s), and/or frequency)	No. Examined (size [TL cm]) or age range, mean size)	Primary Prey in Order of Importance by FO, IRI, TDW, TN, TV, and/or TW
Weiss (1970)	Eastern Long Island Sound	1967-69 (monthly)	557 (1.7-9.7, mean = 6.3)	FO -- Atlantic rock crab, unidentified fish, *Lacuna vincta*, *Nereis* sp., blue mussel, *Astyris* (*Mitrella*) *lunata*, and *Zostera marina*.
Steimle and Terranova (1991)	New York Bight apex	1982-85 (seasonally)	33 (not noted)	FO -- Atlantic rock crab, *Nucula*, *Ovalipes ocelatus*, *Pherusa affinis*, juvenile American lobster, fish, squid, and unidentified polychaetes.
Steimle (1994)	New York Bight apex	1986-89 (bimonthly)	935 (5-13.5)	FO -- Unidentified fish, Atlantic rock crab, *P. affinis*, *N. proxima*, and *Asterias* sp.
Steimle and Figley (unpubl. data)	Central New Jersey coast artificial reef	1996-97 (Jul-Sep)	99 (6.3-15.0, mean = 8.9)	FO -- Crab fragments (mostly Atlantic rock crab), *Euspira* sp. operculums, shell hash, skate egg case fragments, *Pagurus* sp., unidentified organic matter, *Mytilus* fragments, hydroids, sand, artifacts (*e.g.*, tire rubber particles), and *Asterias* sp.

Table 36. Summary of Hudson-Raritan Estuary tautog diet by sampling period during 1996-97, expressed as the percent frequency of occurrence of dominant prey or items (FO), and as the mean percent contribution of dominant prey or items to total stomach content volume (TV). (n = sample size; ES = percent of empty stomachs.)

Prey	Sampling Period: Jul 96 (n = 16; ES = 0) FO	TV	Oct 96 (n = 4; ES = 50) FO	TV	Jan 97 (n = 1; ES = 0) FO	TV	Apr 97 (n = 11; ES = 0) FO	TV	Aug 97 (n = 13; ES = 0) FO	TV	Nov 97 (n = 6; ES = 67) FO	TV
Atlantic rock crab	8.3	8.9	25.0	40.0	100.0	100.0	45.5	29.4	46.2	31.3	16.7	93.9
Xanthid crabs	25.0	12.5	25.0	20.0	0.0	0.0	36.4	19.1	15.4	5.1	0.0	0.0
Blue mussel	33.3	6.6	0.0	0.0	0.0	0.0	27.3	13.0	23.1	17.9	0.0	0.0
Pagurus sp.	0.0	0.0	25.0	40.0	0.0	0.0	0.0	0.0	7.7	2.8	0.0	0.0
Ensis directus	35.0	27.1	0.0	0.0	0.0	0.0	0.0	0.0	7.7	2.3	0.0	0.0
Ovalipes ocellatus	16.7	8.8	0.0	0.0	0.0	0.0	9.1	4.4	0.0	0.0	0.0	0.0
Crangon septemspinosa	8.3	8.9	0.0	0.0	0.0	0.0	9.1	2.2	0.0	0.0	0.0	0.0
Unidentified organic matter	0.0	0.0	0.0	0.0	0.0	0.0	9.1	<0.1	30.8	10.9	0.0	0.0
Juvenile blue crab	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.4	11.5	0.0	0.0

Table 37. Summary of other tautog diet studies for the coastal Middle Atlantic Bight. (Major prey taxa ranked in relative order of importance by: mean percent frequency of occurrence (FO), mean percent contribution to total stomach content volume (TV),mean percent contribution to total stomach content dry weight (TDW), and mean percent contribution to total number of individual items in the stomach (TN), as available from each source.)

Source	Study Area	Year(s) (month(s), season(s), and/or frequency)	No. Examined (size [TL cm]) or age range, mean size)	Primary Prey in Order of Importance by FO, IRI, TDW, TN, TV, and/or TW
Steimle and Ogren (1982)	New York Bight	1966-67 (Jul-Aug)	57 (23-29)	TV -- Atlantic rock crab, sand dollar (*Echinarachnius parma*), blue mussel, and hydroids.
Olla *et al.* (1974)	Great South Bay, NY	1971-72 (unreported)	25 (20-46, mean = 33)	TV -- "Mussels" and crustaceans (decapods and cirripeds).
Festa (1979)	Little Egg Harbor, NJ	1972-77 (summer/fall)	18 (6-16)	TV -- Isopods (*Idotea* sp.) and mud (xanthid) crabs. FO -- Amphipods, isopods, and nematodes.
			7 (20-32)	TV -- Mud crabs and *Ovalipes ocellatus*. FO -- Mud crabs.
Allen *et al.* (1978)	Hereford Inlet, NJ	1973-77 (biweekly/ monthly)	28 (4-44)	FO -- bivalve mollusks, amphipods, detritus, and polychaetes.

Grover (1982)	New York - southern Long Island	1978 (Aug-Nov)	36 (3-7)	TN -- Copepods and amphipods.
Sogard (1992)	Great Egg Harbor, NJ	1988-89 (summer)	63 (3-8)	FO -- Copepods, amphipods, other crustaceans, and ostracods.
Dorf (1994)	Narragansett Bay, RI	1990-92 (various)	82 (2.5-7)	TDW -- Amphipods, copepods, and shrimp *(Crangon* and *Palaemonetes* sp.). FO -- Copepods, amphipods, and flatworm.
			(7-10)	TDW -- Shrimp and crabs. FO -- Shrimp, flatworms, crabs, and detritus.
Lankford *et al.* (1995)	Delaware Bay	Unknown	Unknown (age 2+)	FO -- blue mussel.
Steimle *et al.* (in review)	Delaware Bay	1989-94 (May/Jun and Aug/Sep)	371 (11.0-58.0, mean =32.0)	TV -- blue mussel, unidentified mollusks, *Metridium senile*, Atlantic rock crab, *Ensis directus*, *Pagurus* sp. FO -- blue mussel, unidentified crustaceans, unidentified mollusks, and *M. senile*.
Steimle and Figley (unpubl. data)	Central New Jersey artificial reef	1997 (May-Aug)	68 (30.6-68.0; mean = 37.9)	FO -- Hydroids, blue mussel spat, Atlantic rock crab, crab remains, caprellid amphipods, *P. longicarpus*, *Euspira* sp., *P. pollicaris*, and gammarid amphipods.

Table 38. Summary of Hudson-Raritan Estuary smooth dogfish diet by sampling period during 1996-97, expressed as the percent frequency of occurrence of dominant prey or items (FO), and as the mean percent contribution of dominant prey or items to total stomach content volume (TV). (n = sample size; ES = percent of empty stomachs.)

	Sampling Period											
	Jul 96 (n = 16; ES = 0)		**Oct 96 (n = 9; ES = 0)**		**Jan 97 (n = 0; ES = N/A)**		**Apr 97 (n = 0; ES = N/A)**		**Aug 97 (n = 17; ES = 0)**		**Nov 97 (n = 0; ES = N/A)**	
Prey	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**	**FO**	**TV**
Atlantic rock crab	81.3	33.2	44.4	16.6	-	-	-	-	5.9	1.5	-	-
Ovalipes ocellatus	81.3	40.2	66.6	29.1	-	-	-	-	0.0	0.0	-	-
Crangon septemspinosa	18.8	4.5	11.1	3.8	-	-	-	-	47.1	13.6	-	-
Ensis directus	25.0	8.8	11.1	0.9	-	-	-	-	23.5	6.5	-	-
Unidentified clam fragments	6.2	8.8	44.4	13.3	-	-	-	-	41.2	14.5	-	-
Xanthid crabs	31.2	11.7	0.0	0.0	-	-	-	-	17.6	6.2	-	-
Unidentified organic matter	0.0	0.0	55.6	25.5	-	-	-	-	0.0	0.0	-	-
Unidentified fish remains	0.0	0.0	11.1	3.8	-	-	-	-	5.9	1.9	-	-
Unidentified crab remains	0.0	0.0	11.1	3.3	-	-	-	-	5.9	1.5	-	-

Table 39. Summary of other smooth dogfish diet studies for the coastal Middle Atlantic Bight. (Major prey taxa ranked in relative order of importance by: mean percent frequency of occurrence (FO), mean percent contribution to total stomach content volume (TV), and mean percent contribution to total stomach content weight (TW), as available from each source.)

Source	**Study Area**	**Year(s) (month(s), season(s), and/or frequency)**	**No. Examined (size [TL cm]) or age range, mean size)**	**Primary Prey in Order of Importance by FO, IRI, TDW, TN, TV, and/or TW**
Linton (1901)	Woods Hole, MA	~1895	16 (unknown)	FO -- Crabs (mud, Atlantic rock, and *Libinia* sp.), fish, squid, and polychaetes.
Field (1907)	Woods Hole, MA	1902-04 (summer)	388 (mean = ~100)	FO -- Atlantic rock crab, *Libinia* sp., American lobster, Atlantic menhaden, *Ovalipes ocellatus*, squid, *Nereis* sp., *Zostera marina*, and *Pagurus* sp.
Breder (1921)	Atlantic City, NJ	1920 (Aug)	102 (30-64)	FO -- Crabs, detritus, *Z. marina*, and fish.
Kimmel (1973)	Mouth of Chesapeake Bay	1971-72 (Dec-Sep)	6 (26-53)	TV -- *Upogebia* sp., *Ensis directus*, and *O. ocellatus*.

Festa (1979)	Little Egg Harbor, NJ	1972-77 (summer)	12 (39-56)	TV -- blue crab and juvenile weakfish. FO -- blue crab, *Palaemonetes* sp., and *Crangon*.
Rountree and Able (1996)	Little Egg Harbor, NJ	1988-90 (Apr-Nov)	85 (32-59)	TW -- blue crab, unidentified crabs, *Palaemonetes* sp., *Libinia* sp., *Crangon*, *O. ocellatus*, and polychaetes.
Steimle (unpubl. data)	Delaware Bay	1989-94 (May/Jun and Aug/Sep)	110 (39-115, mean = 71)	TV -- Atlantic rock crab, *Pagurus* sp., *E. directus*, and unidentified decapods. FO -- Atlantic rock crab, *Pagurus* sp., *E. directus*, and unidentified decapods.
Gelsleichter *et al.* (1999)	Mouth of Chesapeake Bay	1980-92	64 (46-126+, mode ~ 106-115)	TW -- Atlantic rock crab, blue crab, *O. ocellatus*, *E. directus*, and various fish. FO -- Atlantic rock crab, blue crab, *O. ocellatus*, *E. directus*, and various fish.

Table 40. Summary of Hudson-Raritan Estuary silver hake diet by sampling period during 1996-97, expressed as the percent frequency of occurrence of dominant prey or items (FO), and as the mean percent contribution of dominant prey or items to total stomach content volume (TV). (n = sample size; ES = percent of empty stomachs.)

	Sampling Period											
	Jul 96 (n = 0; ES = N/A)		Oct 96 (n = 1; ES = 0)		Jan 97 (n = 6; ES = 0)		Apr 97 (n = 6; ES = 0)		Aug 97 (n = 0; ES = N/A)		Nov 97 (n = 29; ES = 7)	
Prey	FO	TV	FO	TV	FO	TV	FO	TV	FO	TV	FO	TV
Crangon septemspinosa	-	-	100.0	100.0	100.0	94.9	66.7	32.6	-	-	24.1	11.8
Neomysis americana	-	-	0.0	0.0	16.7	5.1	50.0	15.2	-	-	37.9	16.1
Unidentified juvenile fish	-	-	0.0	0.0	0.0	0.0	50.0	28.3	-	-	31.0	14.9
Ampelisca abdita	-	-	0.0	0.0	0.0	0.0	16.7	10.9	-	-	31.0	11.2
Gammarus lawrencianus	-	-	0.0	0.0	0.0	0.0	16.7	10.9	-	-	31.0	12.4
Juvenile silver hake	-	-	0.0	0.0	0.0	0.0	0.0	0.0	-	-	3.4	5.6
Calanoid copepods	-	-	0.0	0.0	0.0	0.0	0.0	0.0	-	-	13.7	4.3
Unidentified organic matter	-	-	0.0	0.0	0.0	0.0	16.7	2.2	-	-	6.9	1.2

Table 41. Summary of other juvenile-or-older silver hake diet studies for the coastal Middle Atlantic Bight. (Major prey taxa ranked in relative order of importance by: mean percent frequency of occurrence (FO), mean percent contribution to total stomach content weight (TW), mean percent contribution to total stomach content dry weight (TDW), and an index of relative importance (IRI), as available from each source.)

Source	Study Area	Year(s) (month(s), season(s), and/or frequency)	No. Examined (size [TL cm]) or age range, mean size)	Primary Prey in Order of Importance by FO, IRI, TDW, TN, TV, and/or TW
Smith (1950)	Block Island Sound	1948-49 (seasonally)	Unknown	TW -- Nekton (fish and squid), *Crangon*, and *Leptocheirus pinguis*.
Richards (1963)	Long Island Sound	1956-57 (seasonally)	Sand station - 111 (7-21) Mud station - 165 (6-22)	FO -- *Neomysis*, *Crangon*, *L. pinguis*, and fish (bay anchovy, sand lance, and juvenile silver hake). FO -- Copepods, *Neomysis*, *L. pinguis*, *Crangon*, squid, and bay anchovy.
Schaefer (1960)	Long Branch, NJ, pier	1957-58 (Dec-Jan)	137 (~23-43)	FO -- Amphipods, fish, *Crangon*, blueback herring, *Menidia*, and mysids. TV -- Blueback herring, *Menidia*, juvenile silver hake, fish, and *Crangon*.

Schaefer (1960)	New York Bight apex	1958 (Feb-May)	201 (~23-43)	FO -- *Crangon*, juvenile silver hake, fish, and mysids. TV -- Juvenile silver hake, *Crangon*, *Loligo*, juvenile red hake, blueback herring, and fish.
Steimle (1985)	New York Bight apex	1968-70 (summer)	235 (7-40, mean = 27)	FO -- *Neomysis*, *Crangon*, and various fish.
Vinogradov (1984)	Southern New England	1968-74 (unreported)	3,233 (unreported)	TW -- Juvenile silver hake, Atlantic mackerel, red hake, and squid.
Bowman *et al.* (1987)	Southern New England	1973-76 (spring/fall)	580 (<10)	TW -- Crustaceans (*Crangon*, *Dichelopandalus leptocerus*, *Neomysis*, and amphipods) and fish (sand lance and juvenile silver hake).
			(11-20)	TW -- *Crangon*, *D. leptocerus*, euphausids, *Neomysis*, juvenile silver hake, and sand lance.
Sedberry (1983)	New York Bight shelf	1976-77 (seasonally)	334 (1-15)	IRI -- *Parathemisto gaudichaudi*, decapod crustaceans, and fish (juvenile red hake and sand lance).
			210 (15-25)	IRI -- Decapod crustaceans, fish, and *P. gaudichaudi*.
Steimle and Terranova (1991)	New York Bight apex	1982-85 (seasonally)	215 (not noted)	FO -- *Crangon*, mysids, fish, *D. leptocerus*, juvenile silver hake, and sand lance.
Steimle (unpubl. data)	New York Bight apex	1986-87 (monthly)	766 (9.0-26.2)	FO -- *Crangon*, *D. leptocerus*, mysids, fish, juvenile silver hake, and sand lance. TV -- *Crangon*, fish, *D. leptocerus*, decapod crustaceans, juvenile silver hake, and sand lance.

Table 42. Most commonly eaten invertebrate prey in the Hudson-Raritan Estuary by the 20 most common predators examined in this survey, in approximate order of their overall frequency of occurrence in the diets

Prey (common name)	Primary Predators (also eaten by other predators)
Crangon septemspinosa (sevenspine bay shrimp or sand shrimp)	Commonly eaten by all but winter flounder and tautog for which they are minor prey.
Neomysis americana (opossum shrimp)	Eaten by all but clearnose & winter skates, tautog, smooth dogfish, and American lobster.
Gammarus lawrencianus (scud amphipod)	Eaten by windowpane, scup, red, spotted & silver hakes, weakfish, northern searobin, and northern kingfish.
Cancer irroratus (Atlantic rock crab)	Mostly juveniles eaten by little, clearnose & winter skates, striped & northern searobin, black sea bass, tautog, smooth dogfish, grubby, American lobster, summer flounder, and red hake.
Ovalipes ocellatus (lady crab or calico crab)	Juveniles mostly eaten by little, winter & clearnose skates, summer flounder, smooth dogfish, spotted hake, striped searobin, and striped bass.
Pagurus spp., *P. longicarpus* (right-handed hermit crabs, longwrist hermit)	Commonly eaten by little skate, American lobster, tautog, smooth dogfish, and smallmouth flounder.
Ampelisca abdita (four-eye amphipod)	Winter flounder, windowpane, scup, weakfish, striped searobin, black sea bass, spot, and silver hake commonly eat these.
Pseudodiaptomus coronatus (red copepod)	Commonly eaten by windowpane, spotted hake, and spot.
Mytilus edulis (blue mussel)	Adults eaten by winter skate and tautog; spat eaten by other predators.
Corophium tuberculatum (tube amphipod)	Weakfish and grubby eat them.
Unciola sp. (tube amphipod)	Eaten by winter flounder and northern searobin.
Dyspanopeus sayi (Say mud crab or xanthid crab)	Eaten mostly by tautog, black sea bass, and smooth dogfish.
Ensis directus (Atlantic jacknife or razor clam)	Siphons and whole clams eaten by little & clearnose skate, smooth dogfish, and tautog.

Callinectes sapidus (blue crab)	Minor use of juveniles by several predators.
Palaemonetes sp., mostly *P. vulgaris* (grass shrimps, marsh grass shrimp)	Found in striped bass and American lobster stomachs.
Dichelopandalus leptocerus (bristled longbeak shrimp or red-beaked shrimp)	Eaten by red hake, with minor use by several other predators.
Asabellides oculata (spaghetti worm)	Minor use only by several predators.
Pherusa affinis (green bristlehead tube worm)	Minor use only by several predators.
Mercenaria mercenaria (northern quahog or hard clam)	Only siphons eaten by winter flounder, and minor use by scup and little skate.
Spisula solidissima (Atlantic surfclam)	Only siphons eaten by winter flounder, and meats by smooth dogfish.
Glycera sp. (blood worm)	Minor use by winter flounder and smooth dogfish.

Table 43. Habitat associations of other, less commonly eaten invertebrate prey in the Hudson-Raritan Estuary, based primarily on Caracciolo and Steimle (1983). (Scientific and common names follow Turgeon *et al.* (1998) and Williams *et al.* (1989).)

Taxa (scientific name)	Habitat	Common Name and Comments
Algae (green, red, brown)	Attached and loose	*Ulva*-type fragments, branches usually found
Hydrozoans (unidentified spp.)	Hard surfaces	"Sea hair," incidentally eaten
Nemerteans (unidentified sp.)	Soft sediments, among mussels	Ribbon or "tapeworm"
Mollusca		
Gastropoda		
Crepidula fornicata	Hard surfaces, marine	Common Atlantic slippersnail, only juveniles usually eaten
Bivalvia		
Nucula sp.	Silty sediments	Nut clam, tiny
Mytilus edulis	Hard surfaces and open bottom	Blue mussel, spat often within hydroids
Mulinia lateralis	Fine-medium estuarine sands	Dwarf surfclam
Tellina agilis	Silty to medium marine sands	Northern dwarf-tellin
Ensis directus	Fine-coarse sands	Atlantic jacknife or razor clam, siphons or eaten whole
Mya arenaria	Soft mud-fine sands	Softshell, usually only siphons nipped
Cephalopoda		
Unidentified squid (*Loligo*?)	Nektonic	Fragments only found
Annelida		
Polychaeta		
Glycera sp.	Soft to medium sands	"Blood worms"
Nephtys sp.	Silty to fine sands	"Painted worms"
Nereis sp.	Silty to medium sands	"Clam worms," swarms to surface at times
Asabellides oculata	Silty sands	Rapid colonizer, "spaghetti worm"
Pherusa affinis	Marine silty sands to mud	Tube dweller
Arthropoda		
Crustacea		
Copepoda		
Pseudodiaptomus coronatus	Near bottom	Bright orange color
Isopoda		
Cyathura sp.	Less saline, silty areas	Tube dweller
Edotea sp.	Silty sediments	Common in detritus
Amphipoda		
Corophium tuberculatum	Silty sands	Tube dweller

Ericthonius sp.	Silty sands	Tube dweller
Unciola sp.	Various sands	Tube dweller
Decapoda		
Dichelopandalus leptocerus	Nektonic	Bristled longbeak or bristlebeak shrimp
Palaemonetes sp.	In and near salt marshes	Grass shrimp (mostly *P. vulgaris*, the marsh grass shrimp)
Callinectes sapidus	Estuarine, mud to sand, vegetation	Blue crab, eaten at smaller sizes
Xanthid crabs	Mud and shellfish beds	Mud crabs (mostly *Dyspanopeus sayi*, the Say mud crab)
Stomatopoda		
Squilla empusa	Burrows in sediments	Mantis shrimp

Table 44. Most commonly eaten fish prey in the Hudson-Raritan Estuary, in approximate order of their overall frequency of occurrence in diets

Prey	Prey Habitat (if definable)	Primary Predators (minor predation by others possible)
Unidentified fish (including scales, bones and otoliths)	Not definable	Windowpane, summer flounder, red, spotted & silver hakes, weakfish, northern searobin, striped bass, clearnose & winter skates, and smooth dogfish
Unidentified juvenile or small flounder	Not definable	Little & winter skates, summer flounder, red & spotted hakes
Unidentified juvenile searobins (*Prionotus* sp.)	Benthic genus, common in warmer months	Minor use of juveniles by little & clearnose skates, summer flounder, red & spotted hakes, striped searobin, and bluefish
Anchovy, *Anchoa* sp. (mostly bay anchovy)	Small, pelagic, schooling species, most common in warmer months	Windowpane, weakfish, northern kingfish; minor use by others
Smallmouth flounder	Small benthic species	Striped bass; minor use by others
Red hake	Benthic species, mostly found in the cooler months	Minor use of juveniles by several species
Goby (naked?), *Gobiosoma* sp.	Minute benthic species, usually associated with shelter, *e.g.*, sponges	Striped bass; minor use by skates
Juvenile silver hake	Semipelagic species, commonly found in cooler months	Weakfish, striped bass, larger silver hake; minor use by others
Juvenile black sea bass	Structure-oriented species, often collected in redbeard sponge patches, probably also found within rocky rip-rap	Minor use by several species
Juvenile Atlantic menhaden	Pelagic, schooling species, summer visitor	Minor use by several species
Juvenile windowpane	Resident species, found widespread throughout the Estuary	Adult red hake; minor use by other species
Juvenile cunner	Resident species usually found near structure	Summer flounder; minor use by skates and red hake
Silversides, *Menidia* sp.	Common, schooling species in shallow water during warmer months	Juvenile bluefish; minor use by others
Rock gunnel	Small, resident species, associated with structure	Minor use by little & clearnose skates, summer flounder, and striped bass
Northern pipefish	Small, semiresident species, often found in algal patches	Minor use by several species

Juvenile winter flounder	Resident species, most common in deeper, silty areas	Clearnose & winter skates; minor use by little skate
Juvenile striped searobin	Benthic, warm season visitor, usually trawled in deeper areas	Adult striped searobin; minor use by a few other species
Juvenile grubby	Small resident species	Minor use by several species
Sand lance, *Ammodytes* sp.	Sand-dwelling species, found in marine areas	Winter skate; minor use by windowpane and little skate
Juvenile weakfish	Semipelagic, summer resident	Minor use by summer flounder, red hake, and adult weakfish
Juvenile river herring, *Alosa* sp.	Schooling species, usually collected in cooler months	Minor use by windowpane and summer flounder
Northern searobin bass	Small, summer resident	Minor use of adults and juveniles by little skate and striped
Butterfish	Small, semipelagic schooling species common in warmer months	Weakfish and bluefish, only
Juvenile American eel	Prefers silty sediments	Clearnose skate and spotted hake
Unidentified juvenile hake, *Urophycis* sp.	Not definable	Striped bass; minor use by clearnose skate
Other juvenile or small fish infrequently preyed upon: Atlantic herring, Atlantic croaker, lined seahorse, scup, conger eel, and northern stargazer (*Astroscopus guttatus*)	Various	Winter skate, windowpane, smooth dogfish, summer flounder, striped bass, and striped searobin

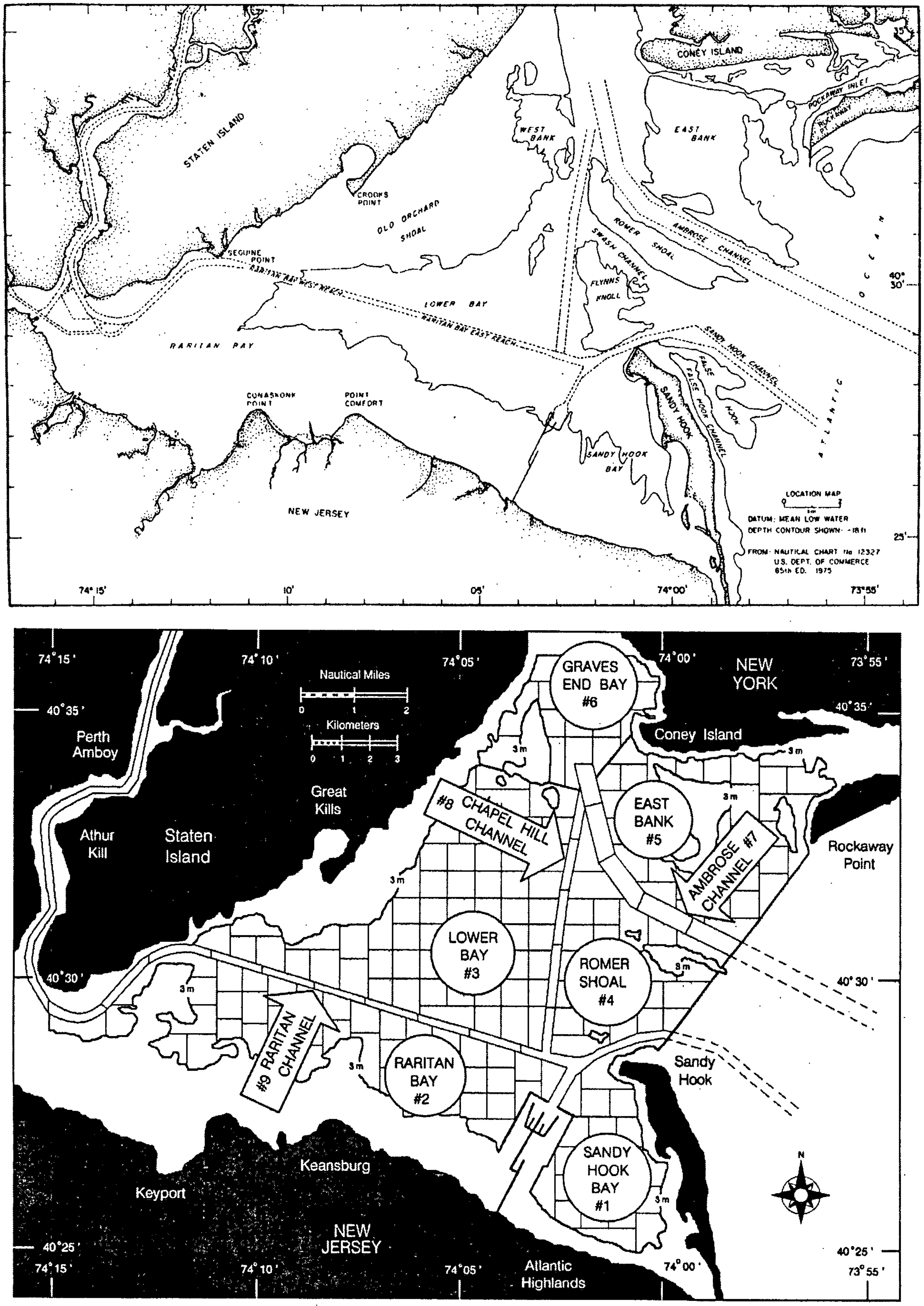

Figure 1. Upper Panel: Habitat features of the Hudson-Raritan Estuary. Lower Panel: Locations of sampling strata (#s 1-9) and blocks in the Hudson-Raritan Estuary.

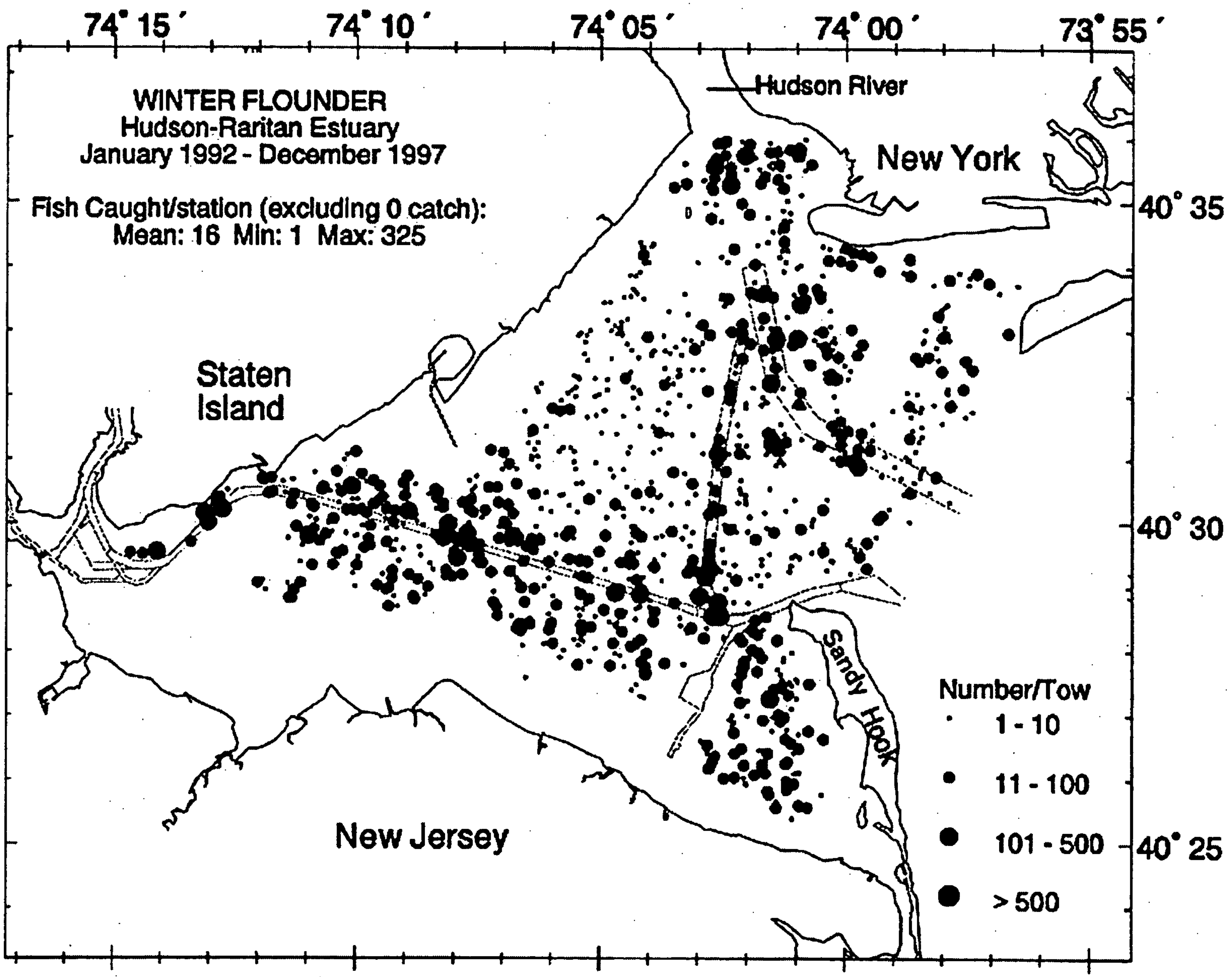

Figure 2. Winter flounder distribution and relative abundance in Hudson-Raritan Estuary, 1992-97 (Wilk et al. 1998).

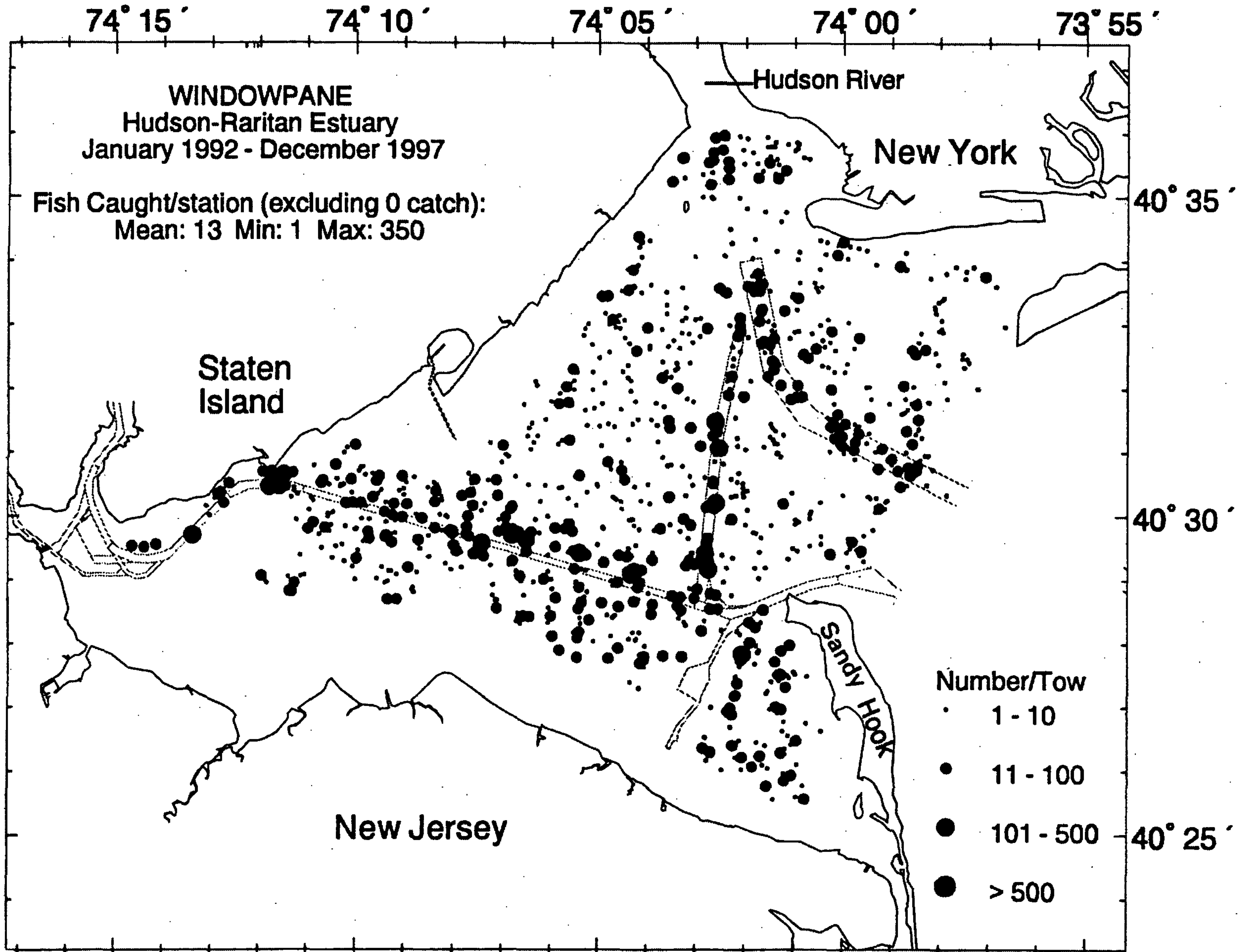

Figure 3. Windowpane distribution and relative abundance in Hudson-Raritan Estuary, 1992-97 (Wilk et al. 1998).

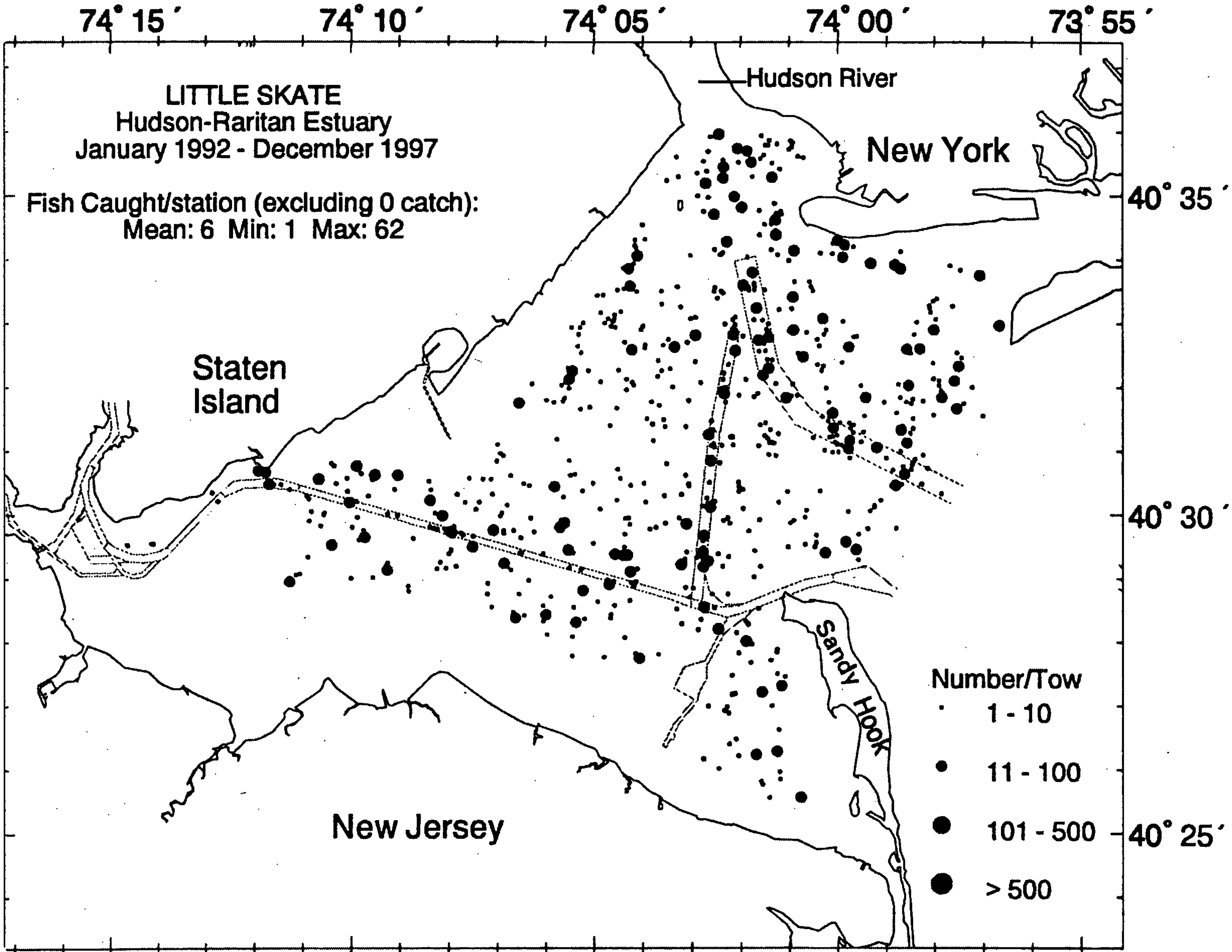

Figure 4. Little skate distribution and relative abundance in Hudson-Raritan Estuary, 1992-97 (Wilk et al. 1998).

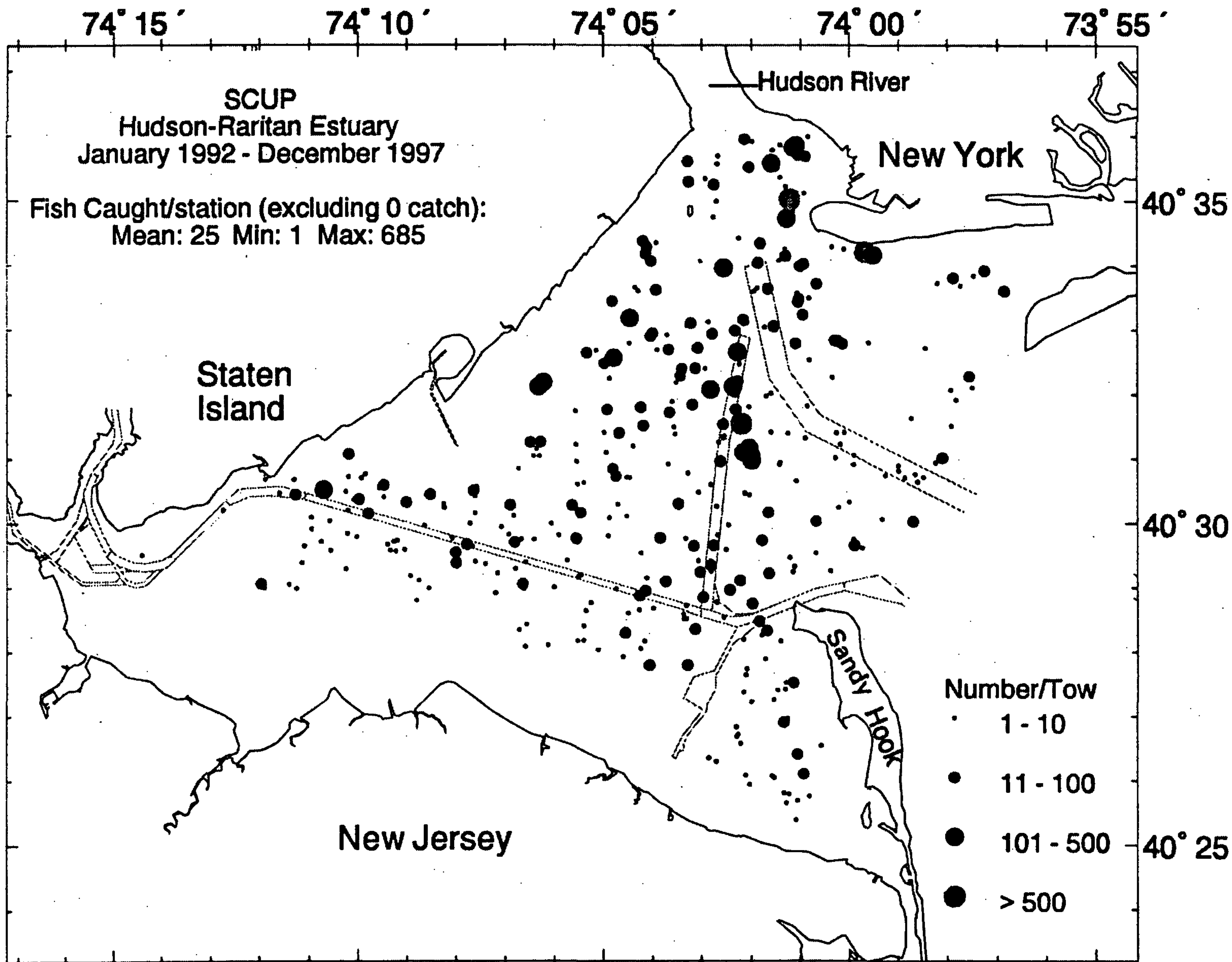

Figure 5. Scup distribution and relative abundance in Hudson-Raritan Estuary, 1992-97 (Wilk et al. 1998).

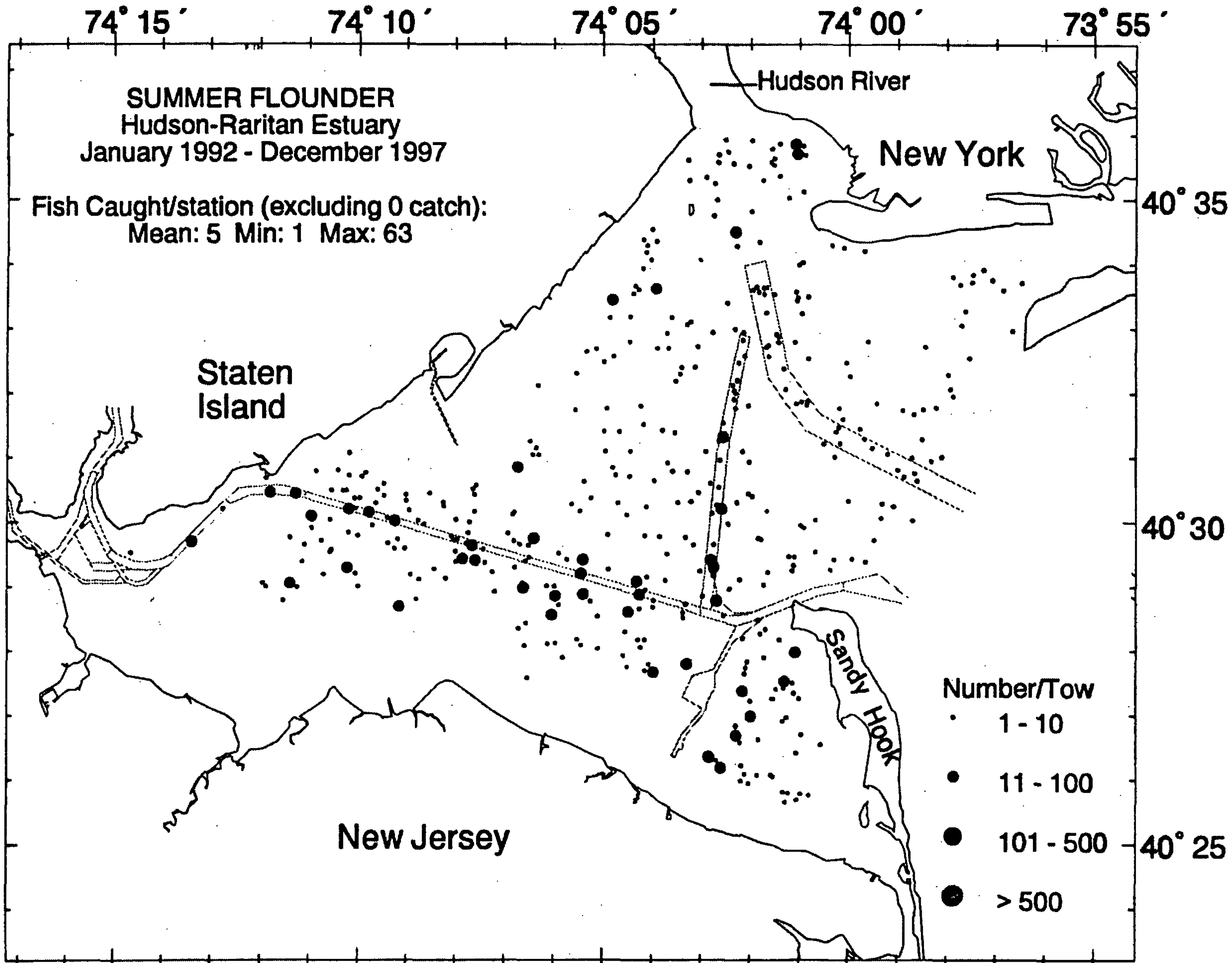

Figure 6. Summer flounder distribution and relative abundance in Hudson-Raritan Estuary, 1992-97 (Wilk et al. 1998).

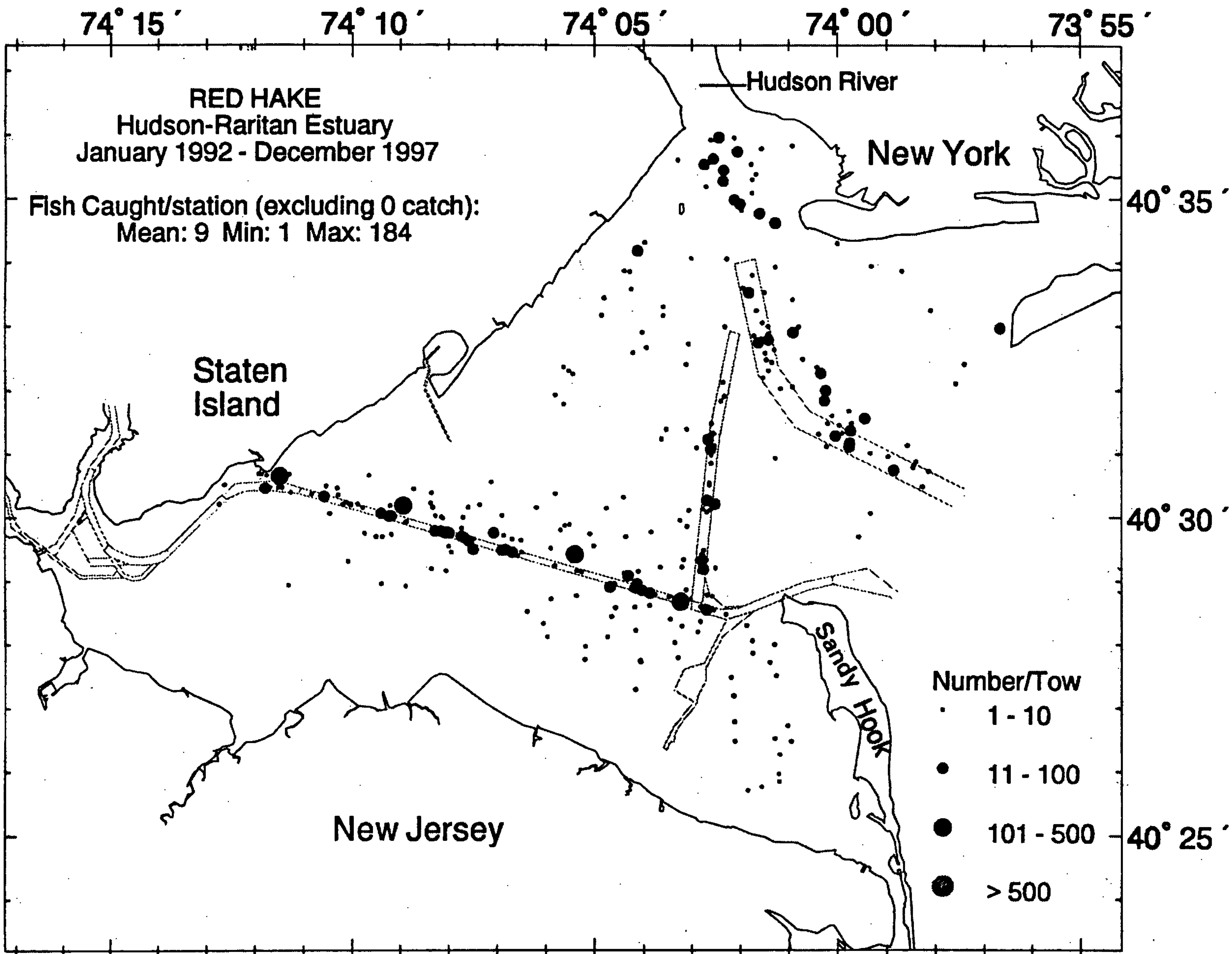

Figure 7. Red hake distribution and relative abundance in Hudson-Raritan Estuary, 1992-97 (Wilk et al. 1998).

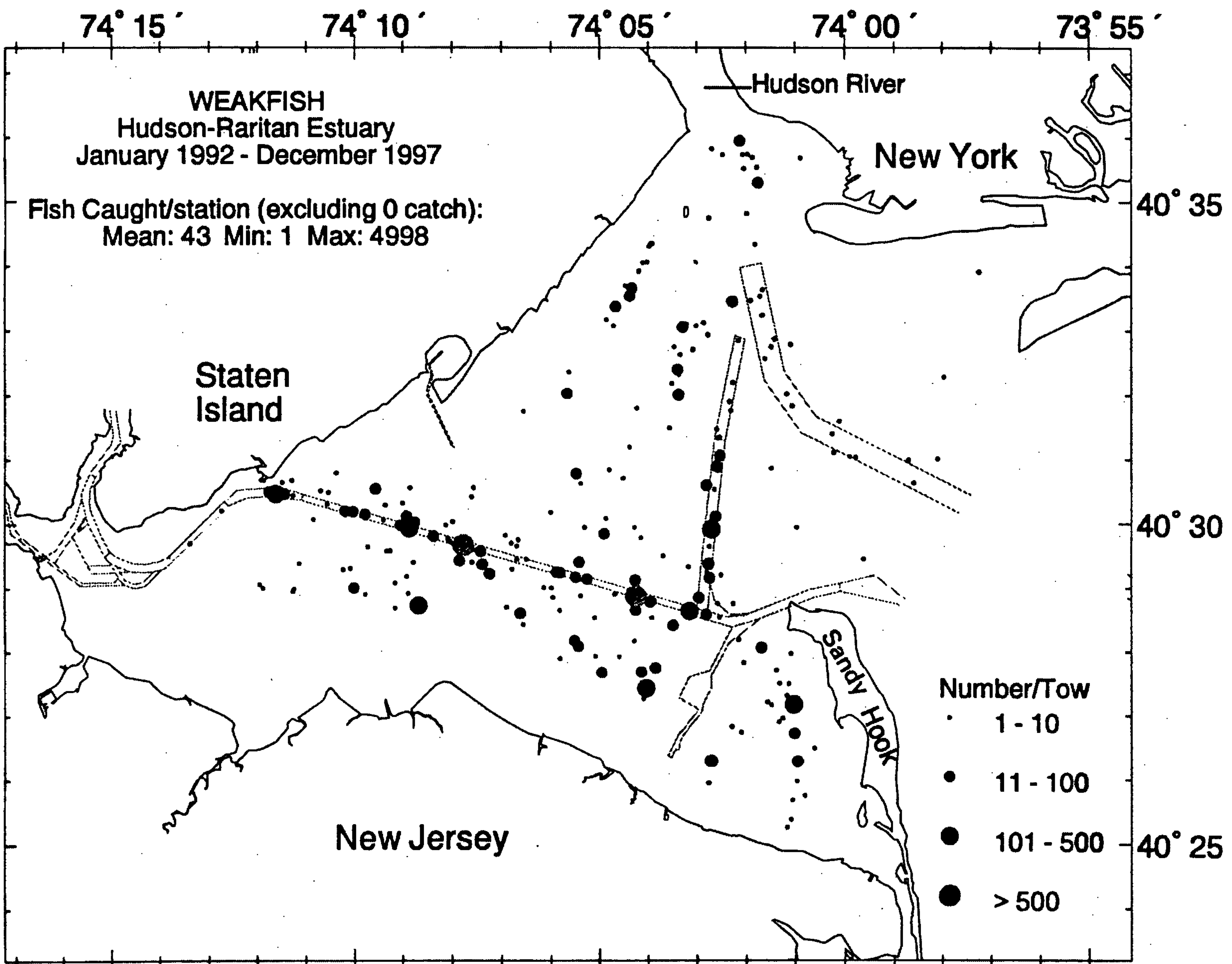

Figure 8. Weakfish distribution and relative abundance in Hudson-Raritan Estuary, 1992-97 (Wilk et al. 1998).

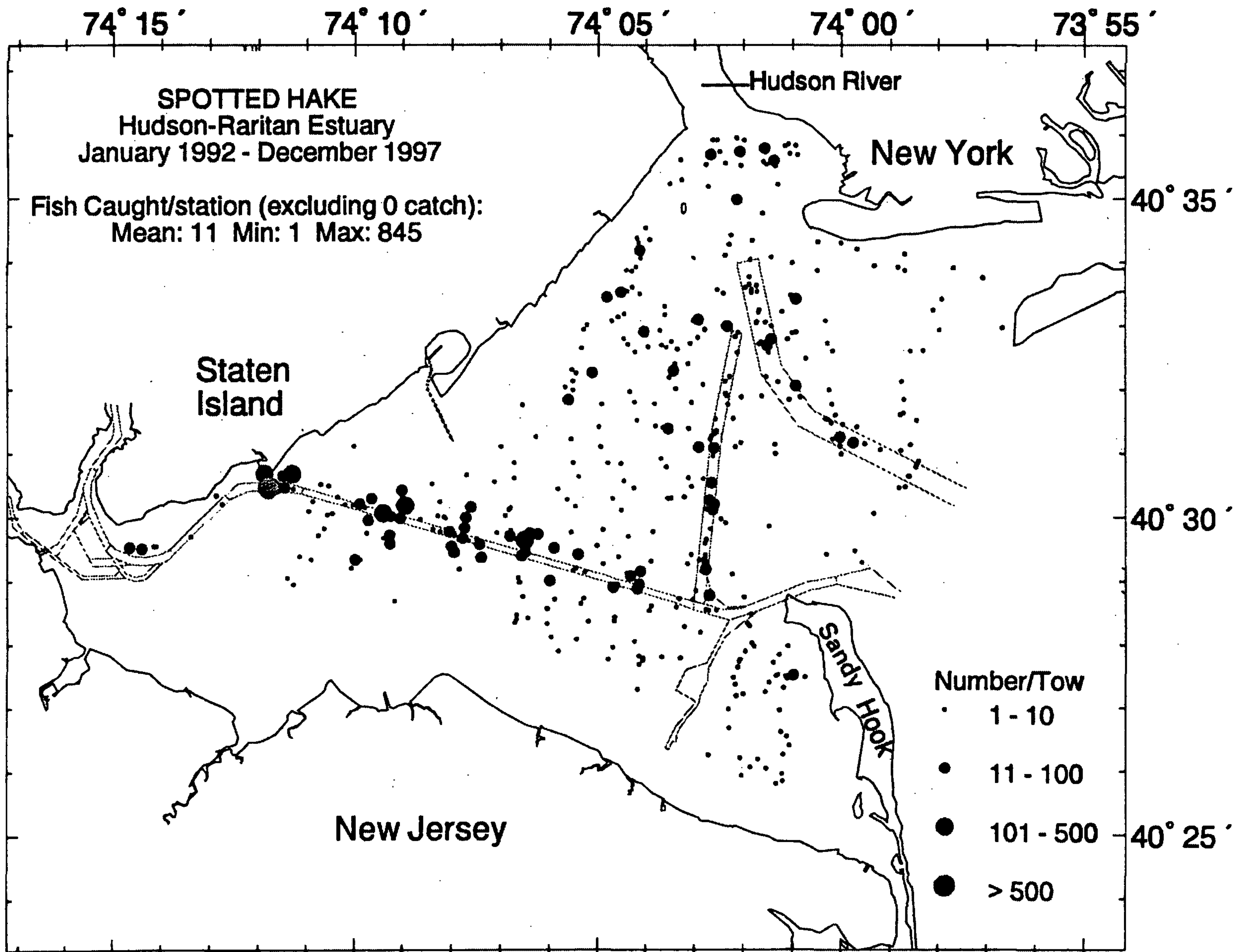

Figure 9. Spotted hake distribution and relative abundance in Hudson-Raritan Estuary, 1992-97 (Wilk et al. 1998).

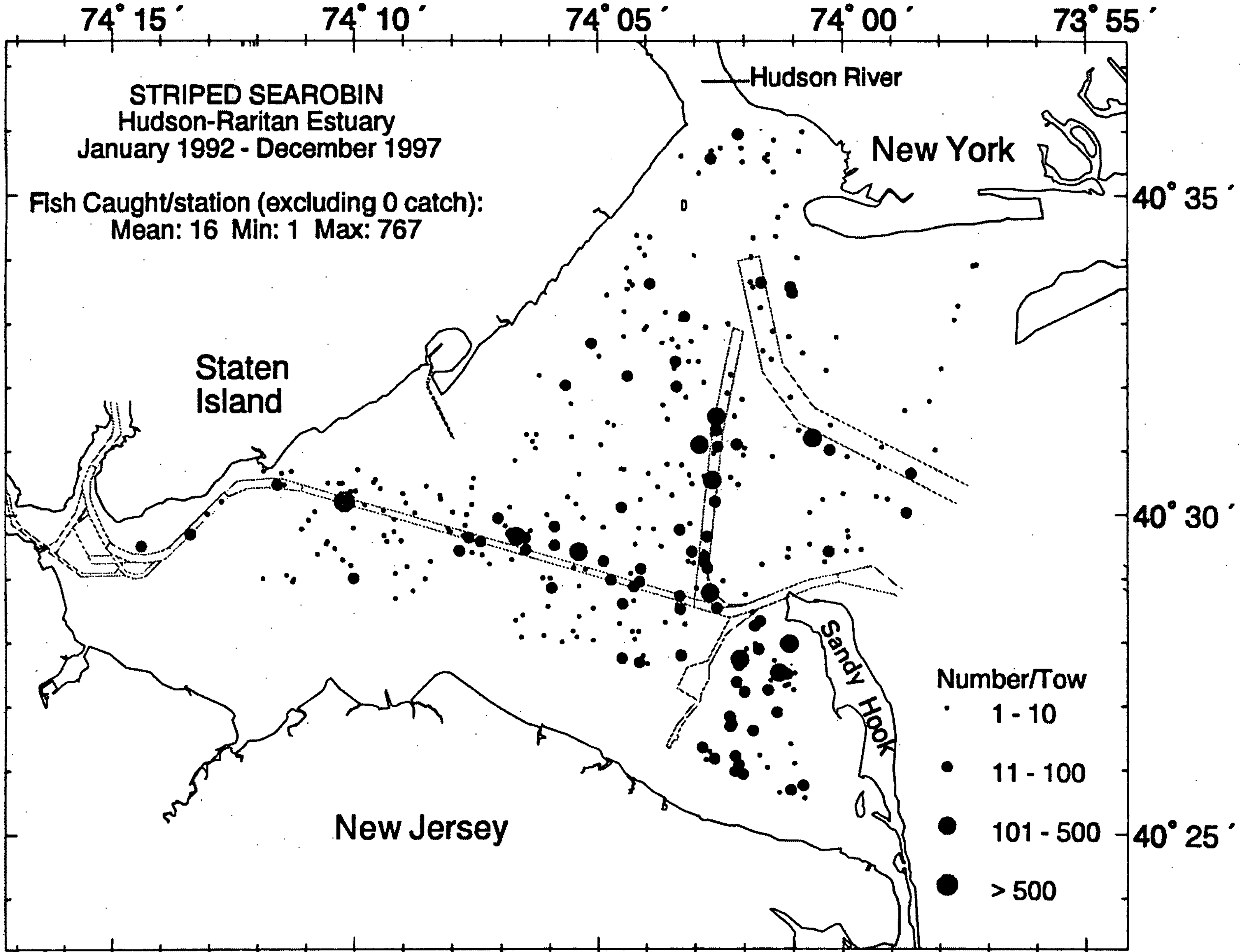

Figure 10. Striped searobin distribution and relative abundance in Hudson-Raritan Estuary, 1992-97 (Wilk et al. 1998).

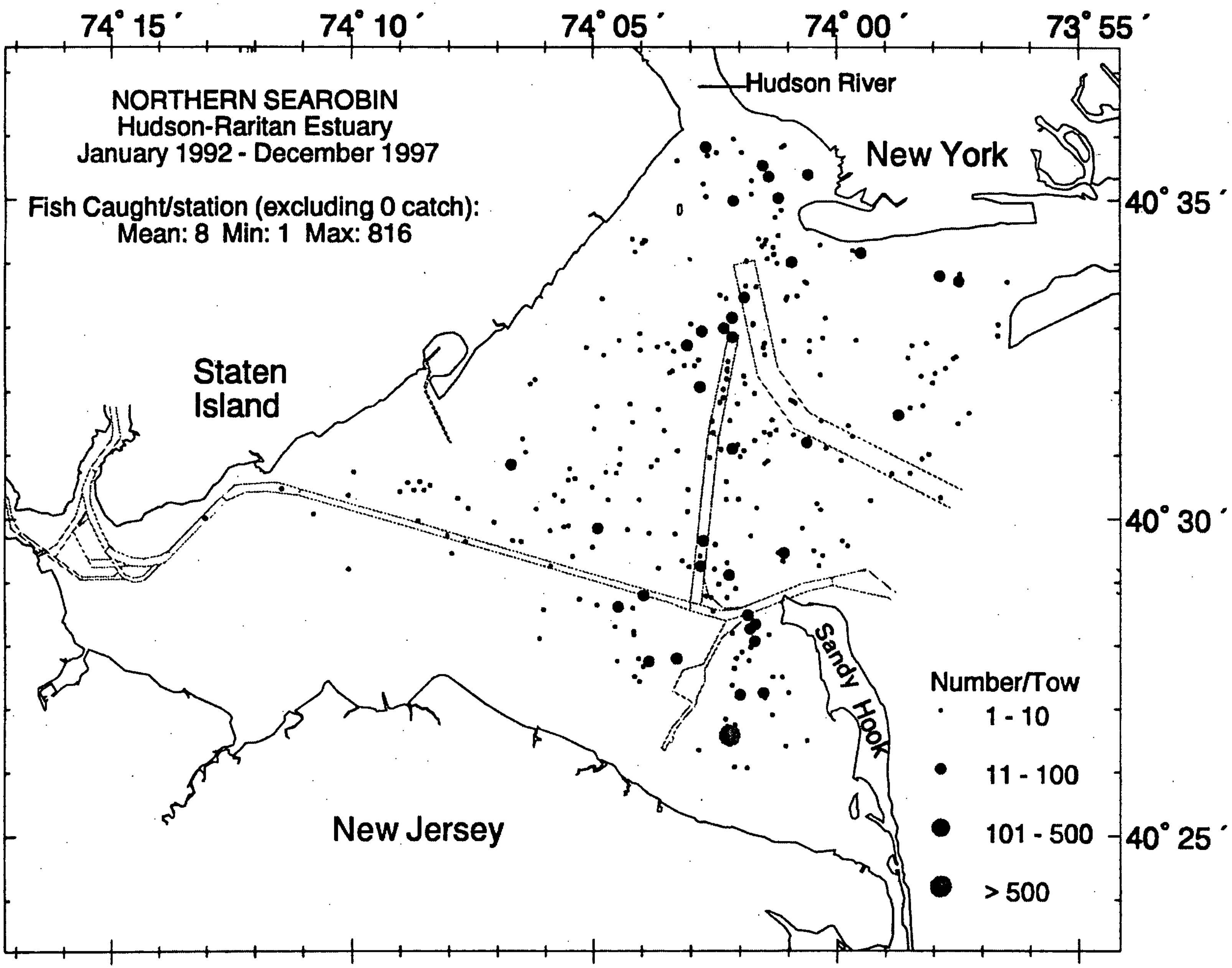

Figure 11. Northern searobin distribution and relative abundance in Hudson-Raritan Estuary, 1992-97 (Wilk et al. 1998).

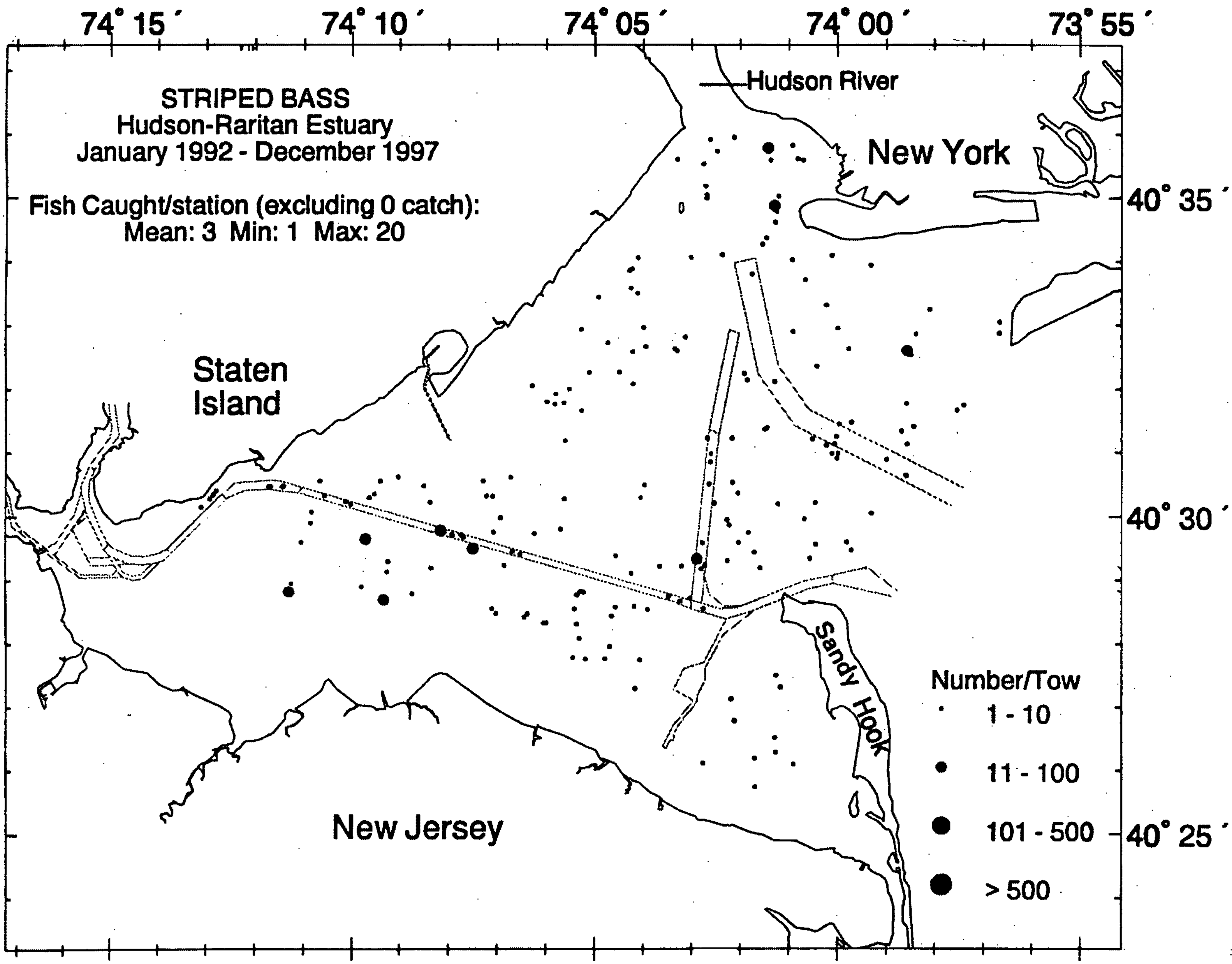

Figure 12. Striped bass distribution and relative abundance in Hudson-Raritan Estuary, 1992-97 (Wilk et al. 1998).

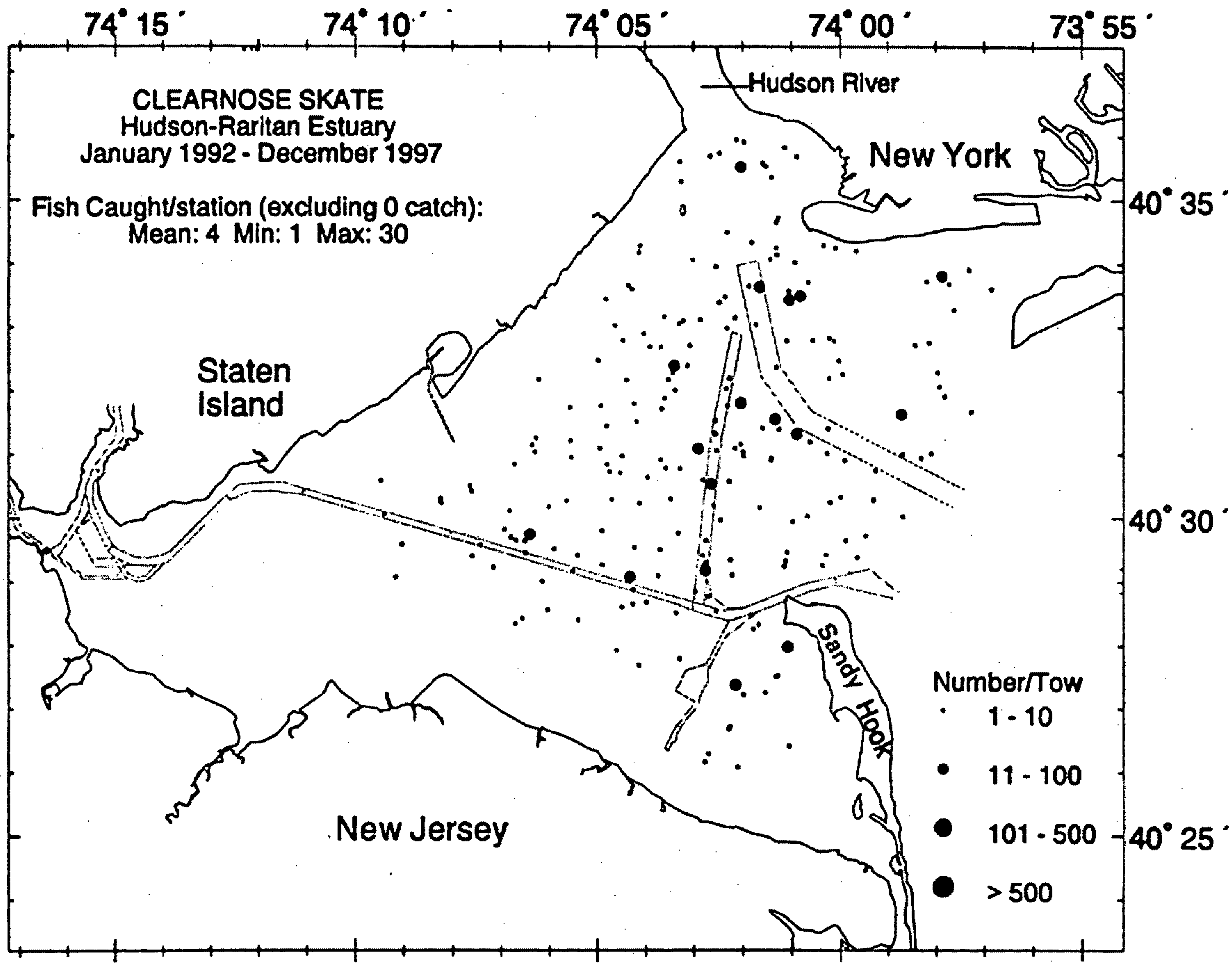

Figure 13. Clearnose skate distribution and relative abundance in Hudson-Raritan Estuary, 1992-97 (Wilk et al. 1998).

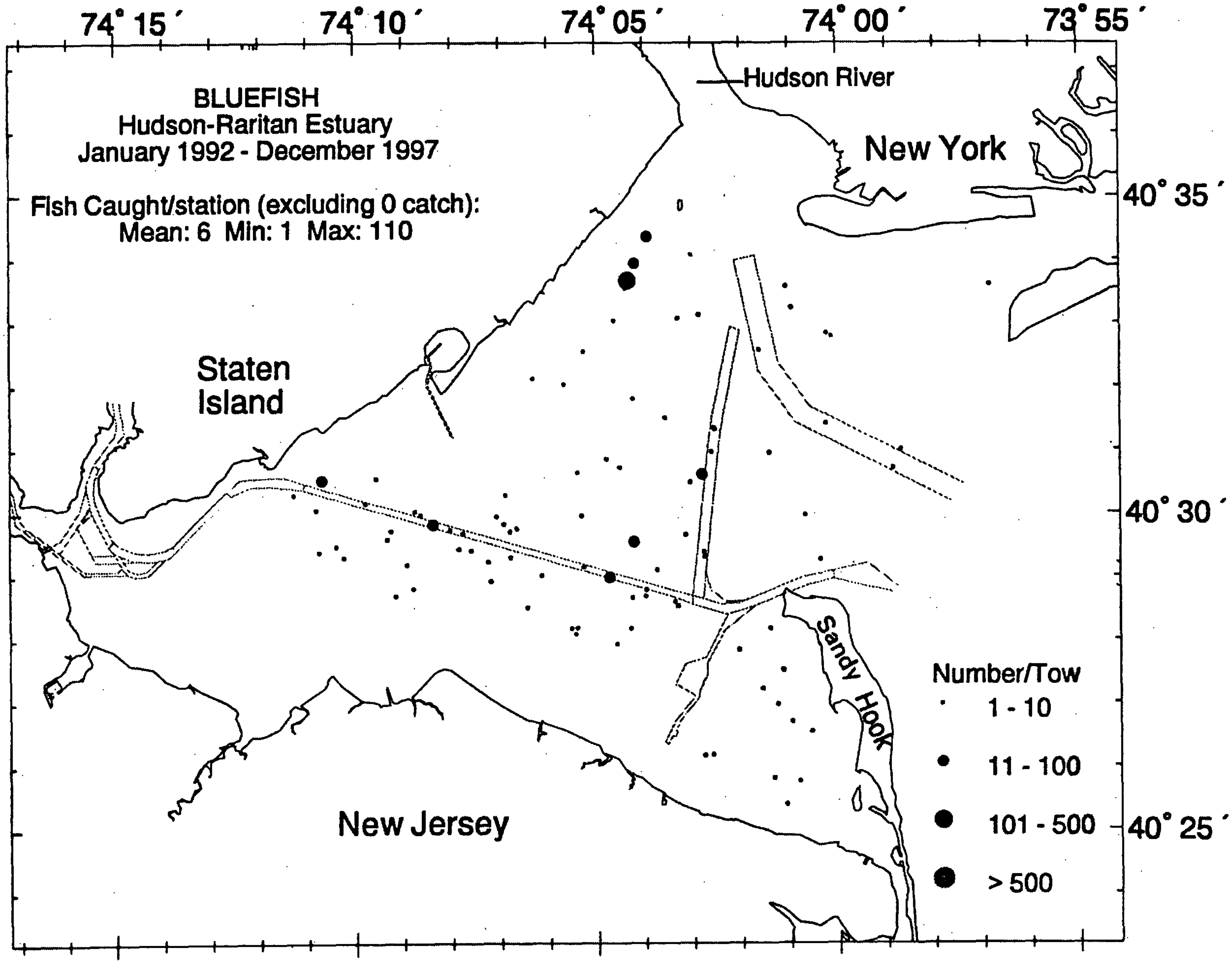

Figure 14. Bluefish distribution and relative abundance in Hudson-Raritan Estuary, 1992-97 (Wilk et al. 1998).

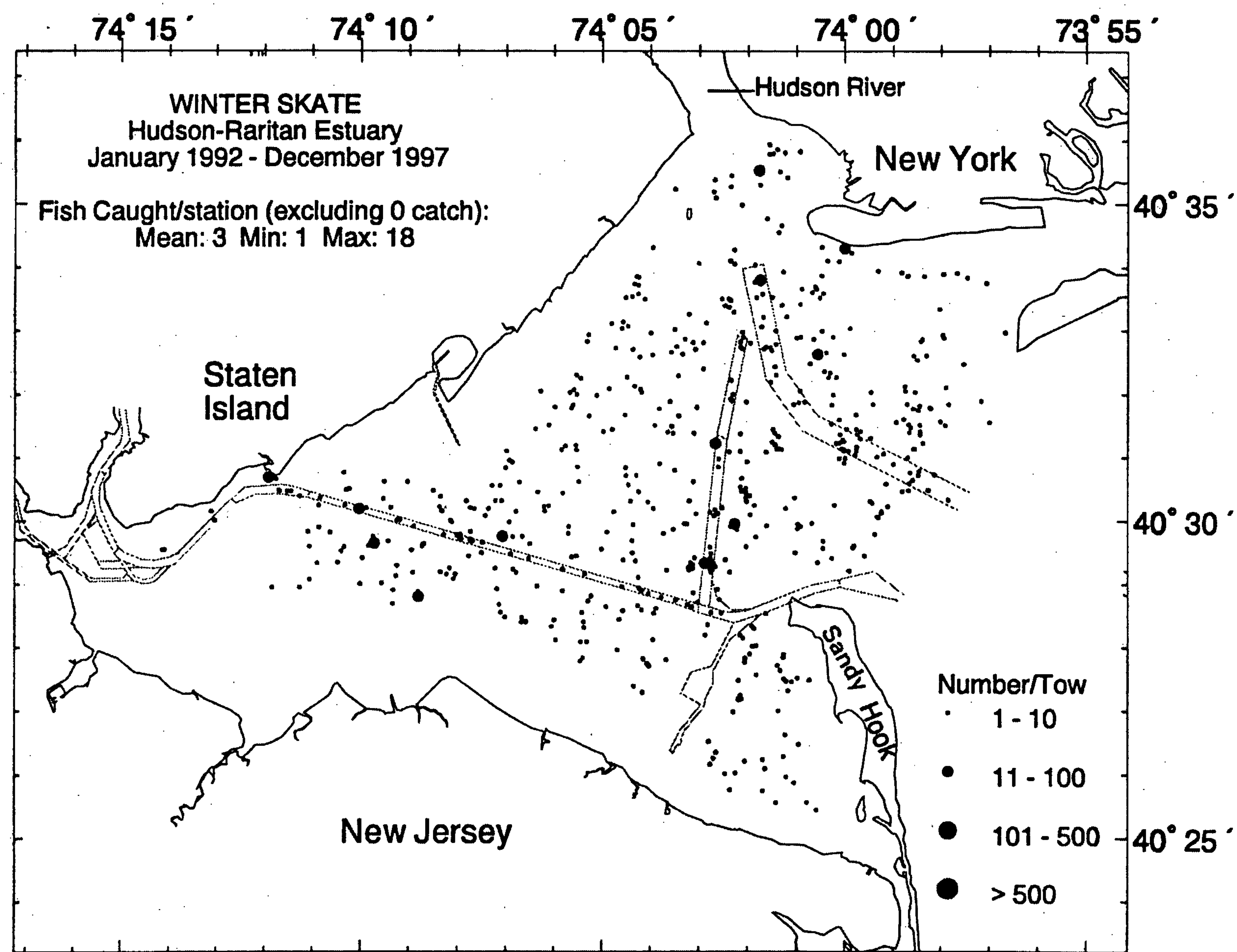

Figure 15. Winter skate distribution and relative abundance in Hudson-Raritan Estuary, 1992-97 (Wilk et al. 1998).

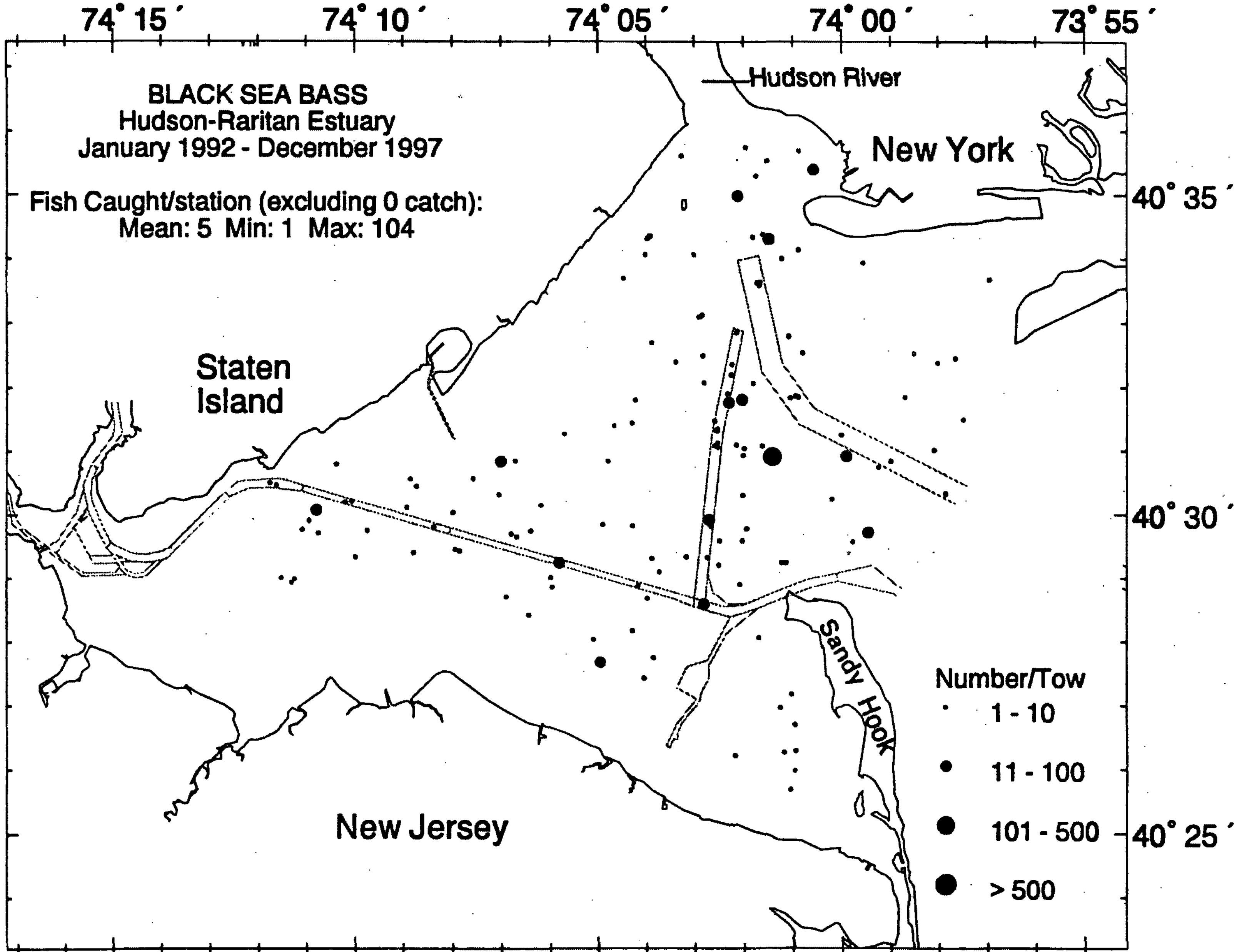

Figure 16. Black sea bass distribution and relative abundance in Hudson-Raritan Estuary, 1992-97 (Wilk et al. 1998).

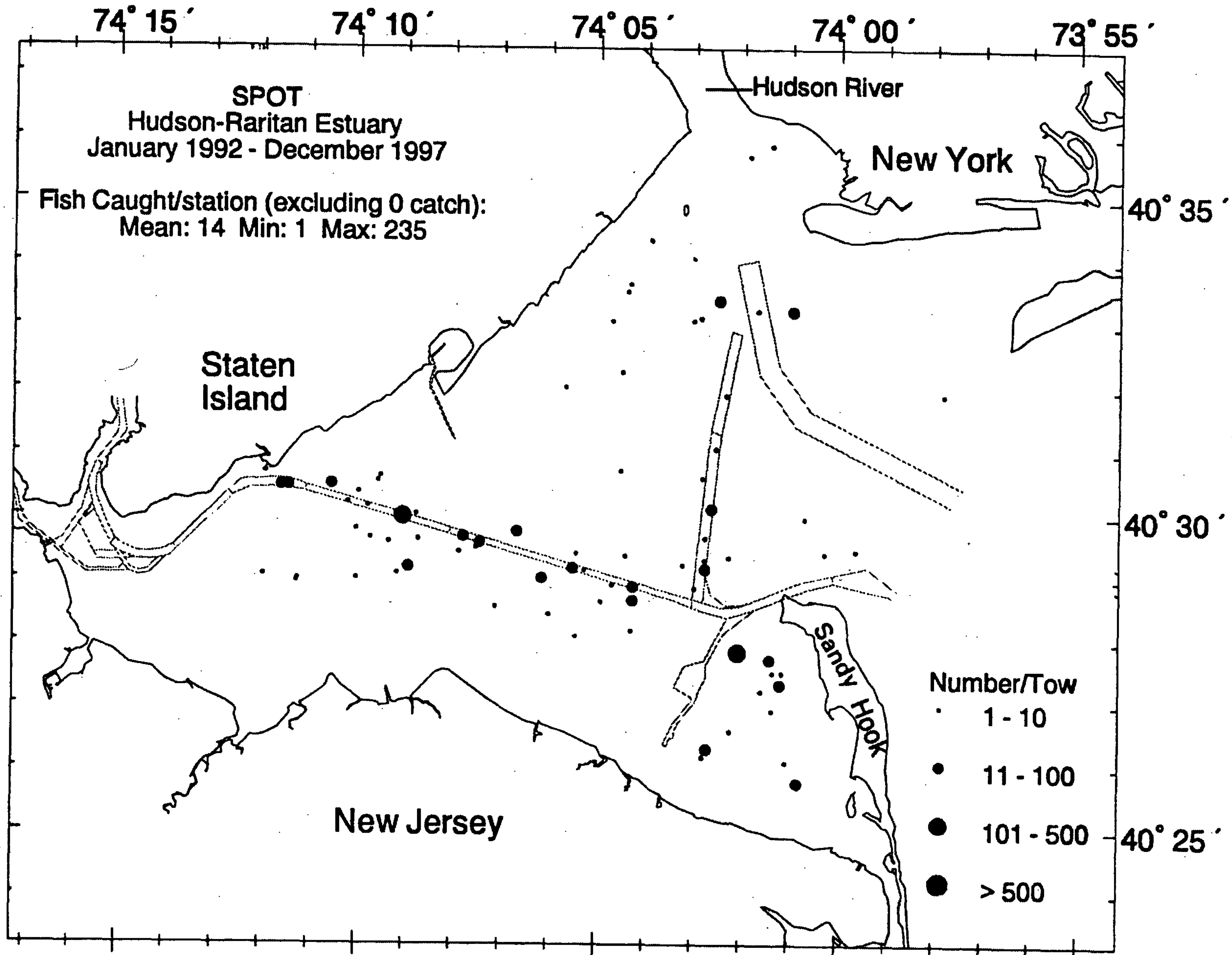

Figure 17. Spot distribution and relative abundance in Hudson-Raritan Estuary, 1992-97 (Wilk et al. 1998).

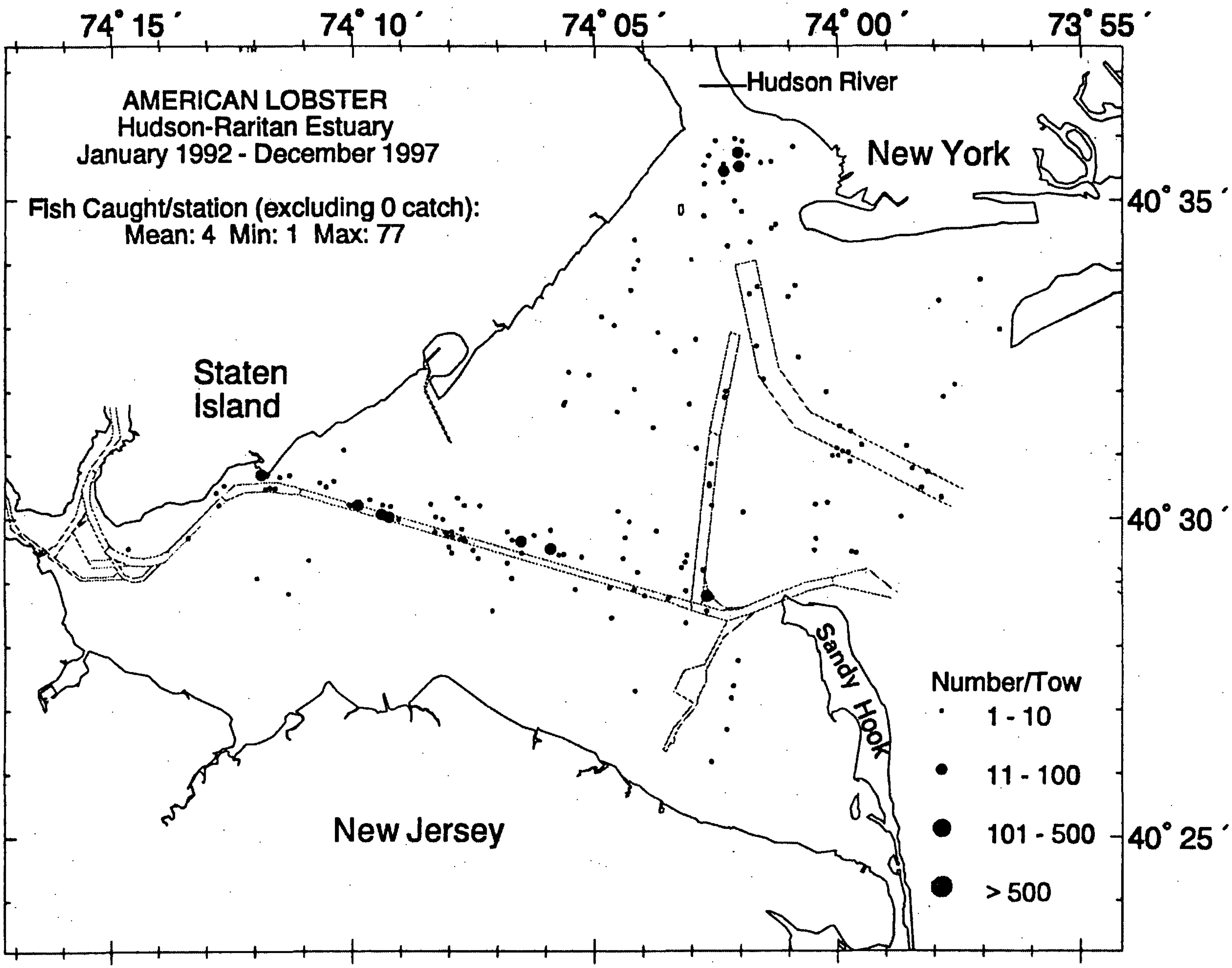

Figure 18. American lobster distribution and relative abundance in Hudson-Raritan Estuary, 1992-97 (Wilk et al. 1998).

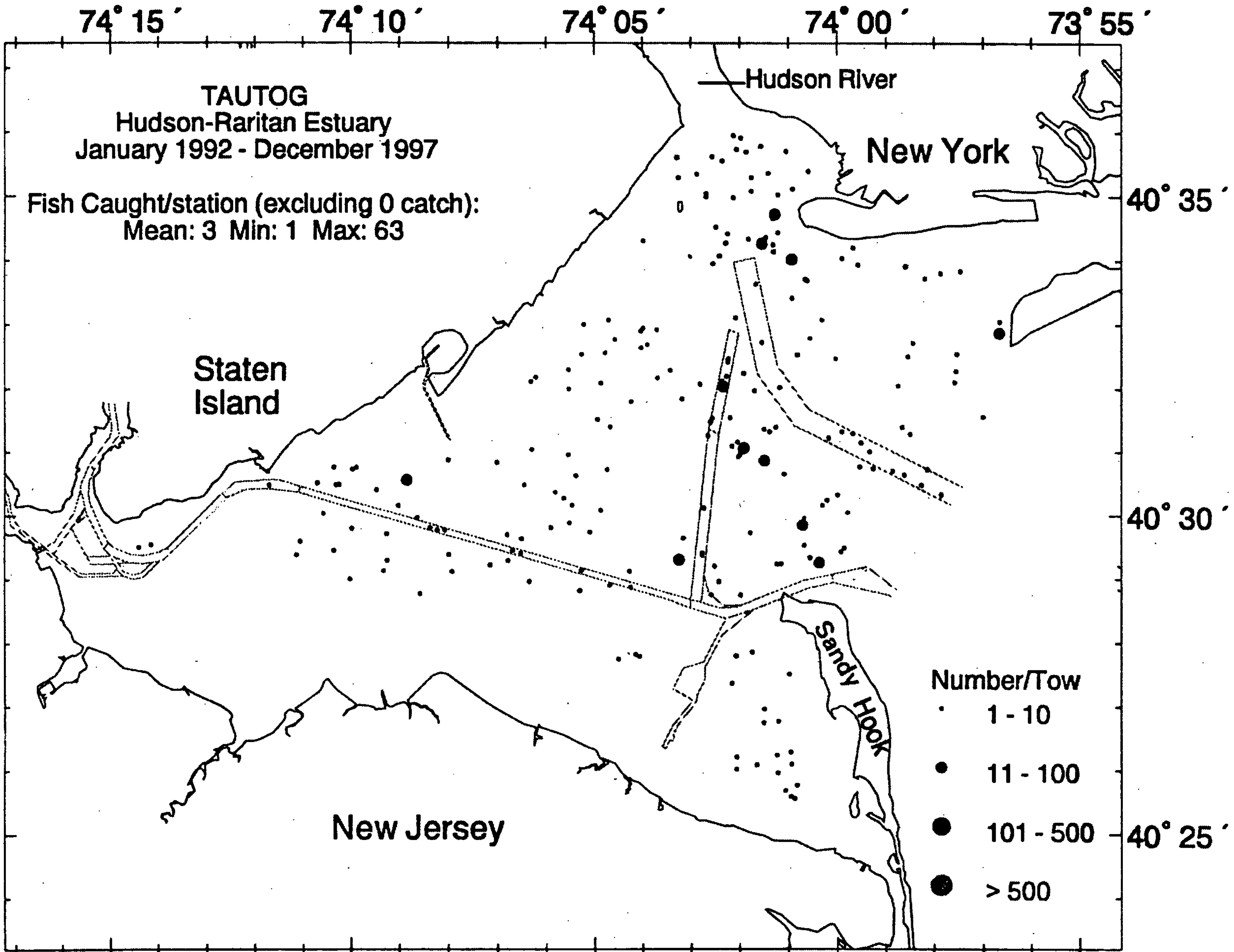

Figure 19. Tautog distribution and relative abundance in Hudson-Raritan Estuary, 1992-97 (Wilk et al. 1998).

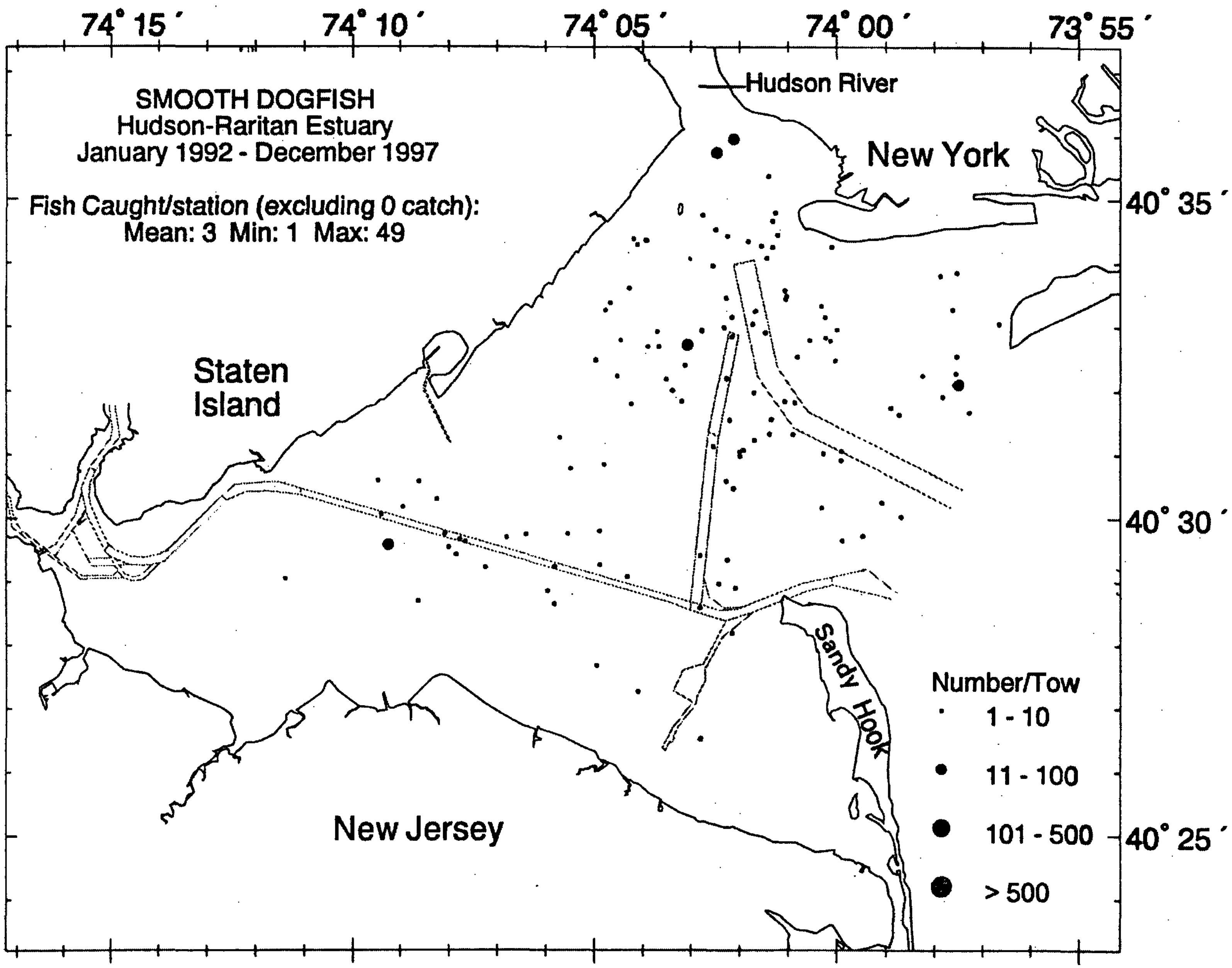

Figure 20. Smooth dogfish distribution and relative abundance in Hudson-Raritan Estuary, 1992-97 (Wilk et al. 1998).

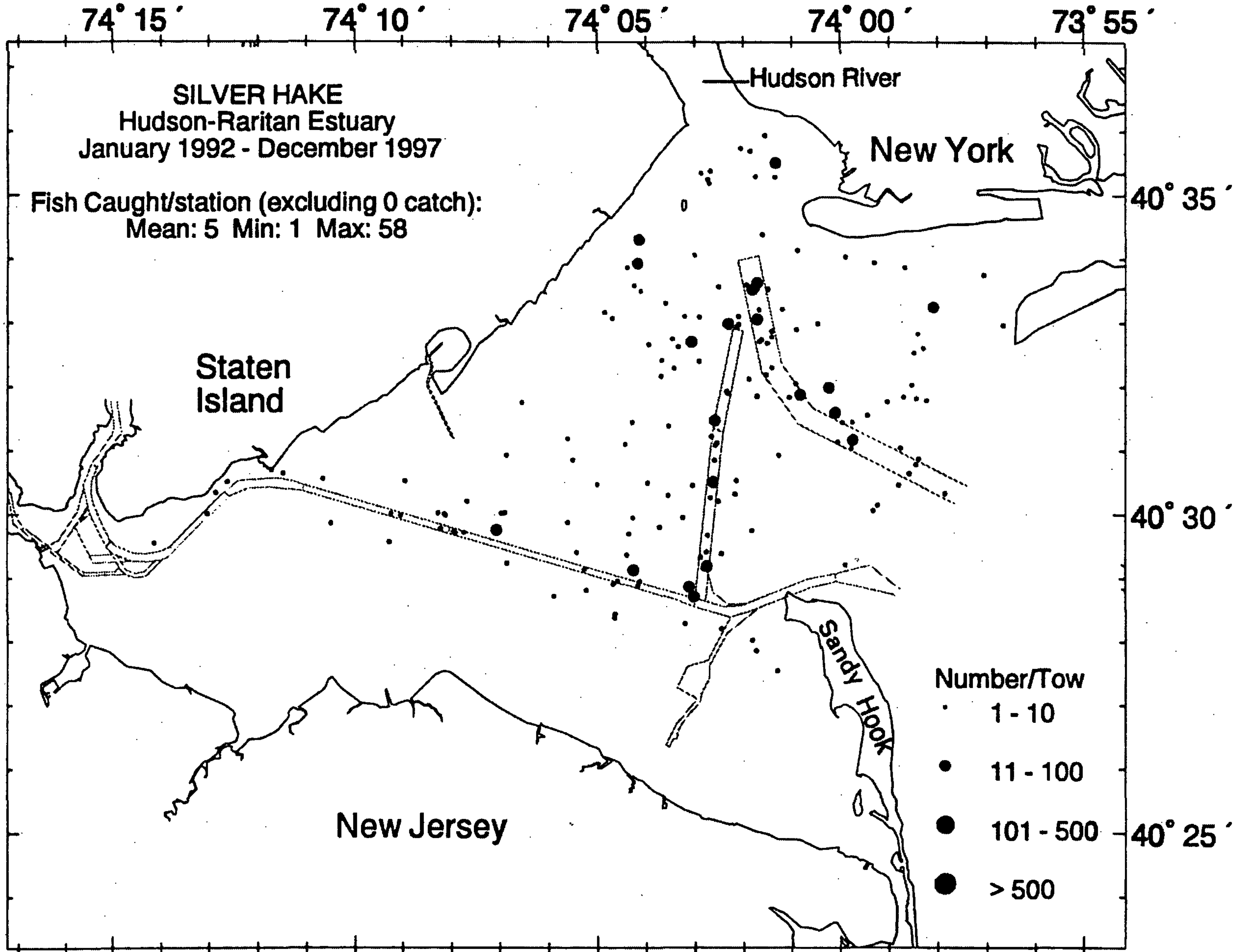

Figure 21. Silver hake distribution and relative abundance in Hudson-Raritan Estuary, 1992-97 (Wilk et al. 1998).

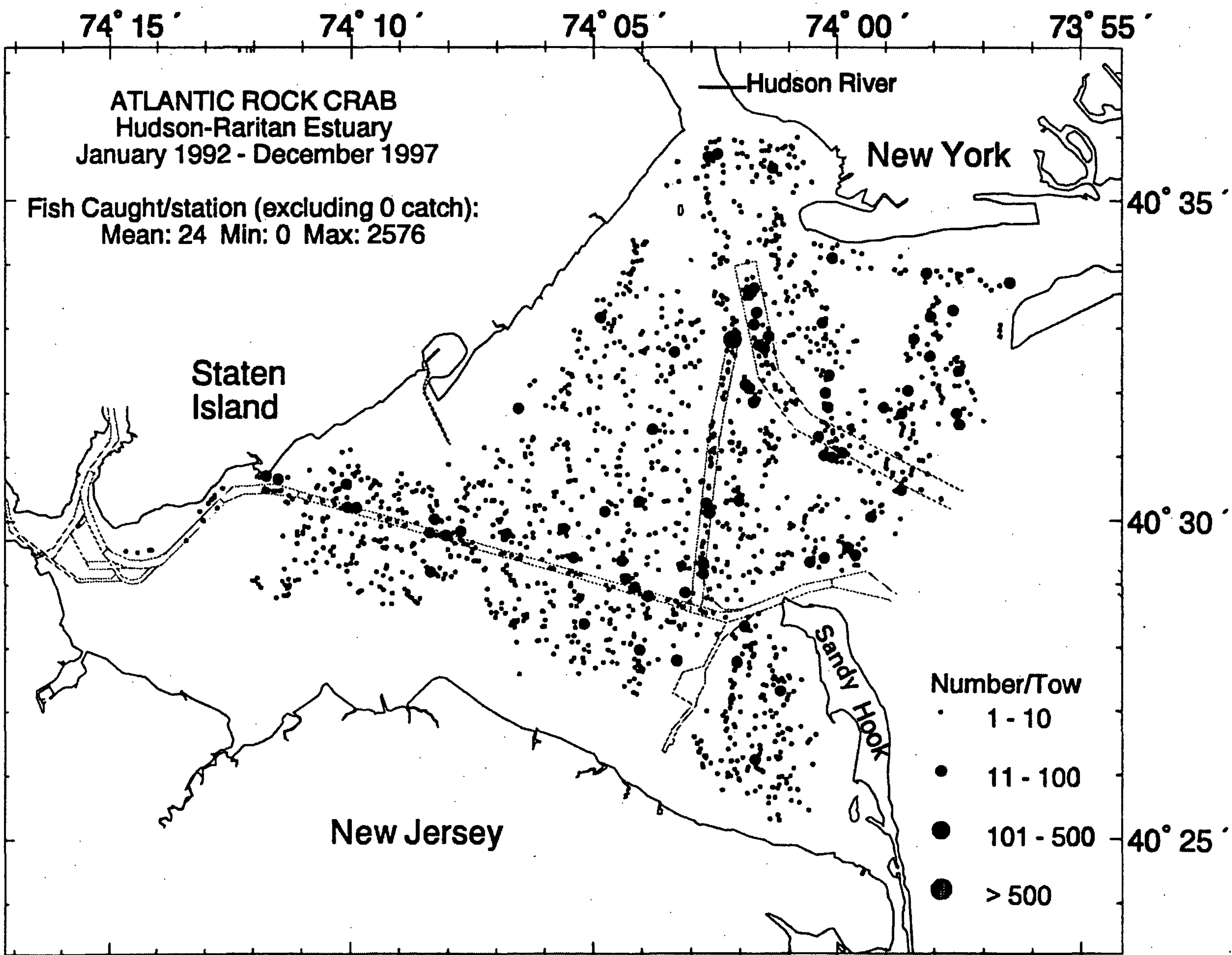

Figure 22. Atlantic rock crab distribution and relative abundance in Hudson-Raritan Estuary, 1992-97 (Wilk et al. 1998).

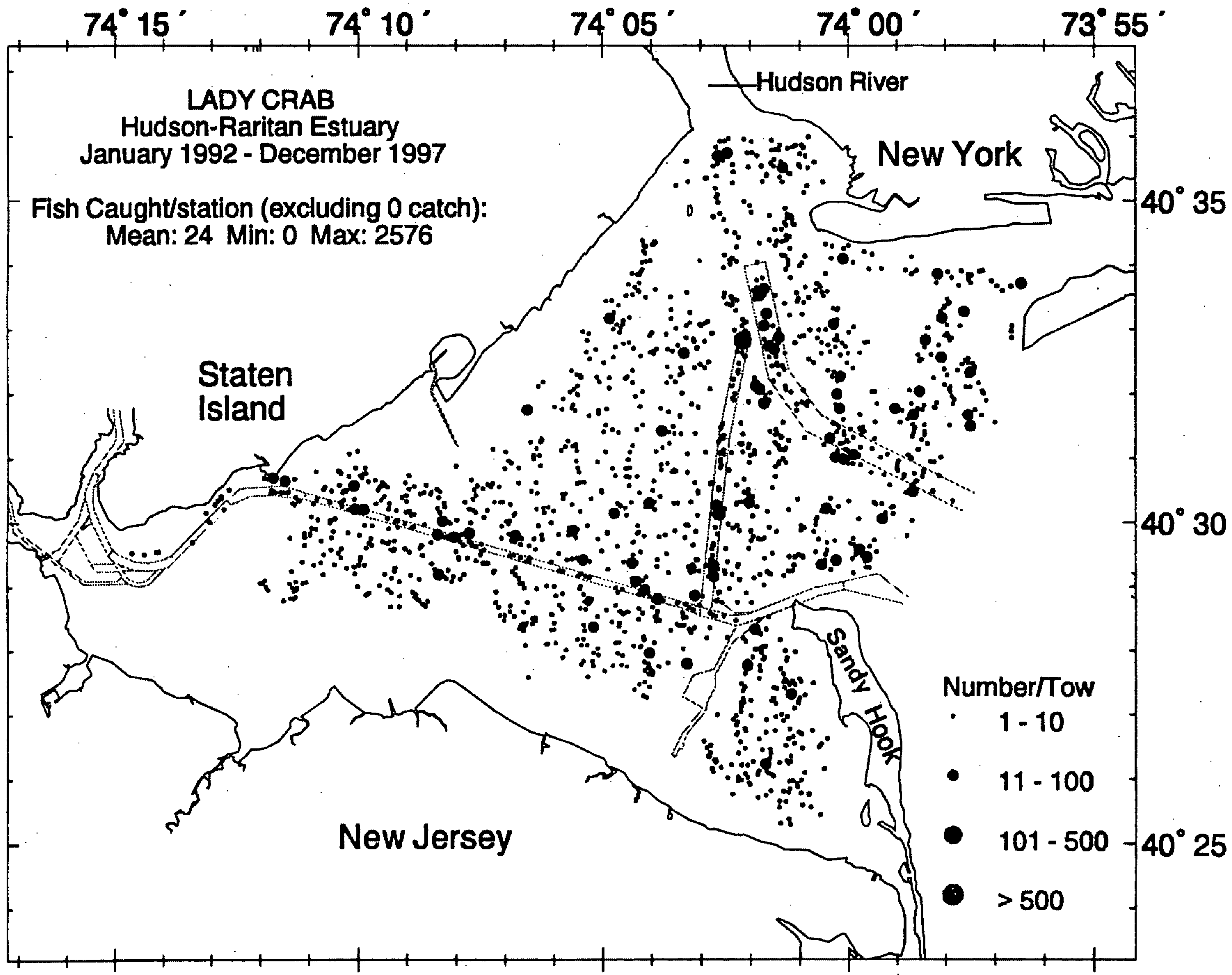

Figure 23. Lady crab distribution and relative abundance in Hudson-Raritan Estuary, 1992-97 (Wilk et al. 1998).

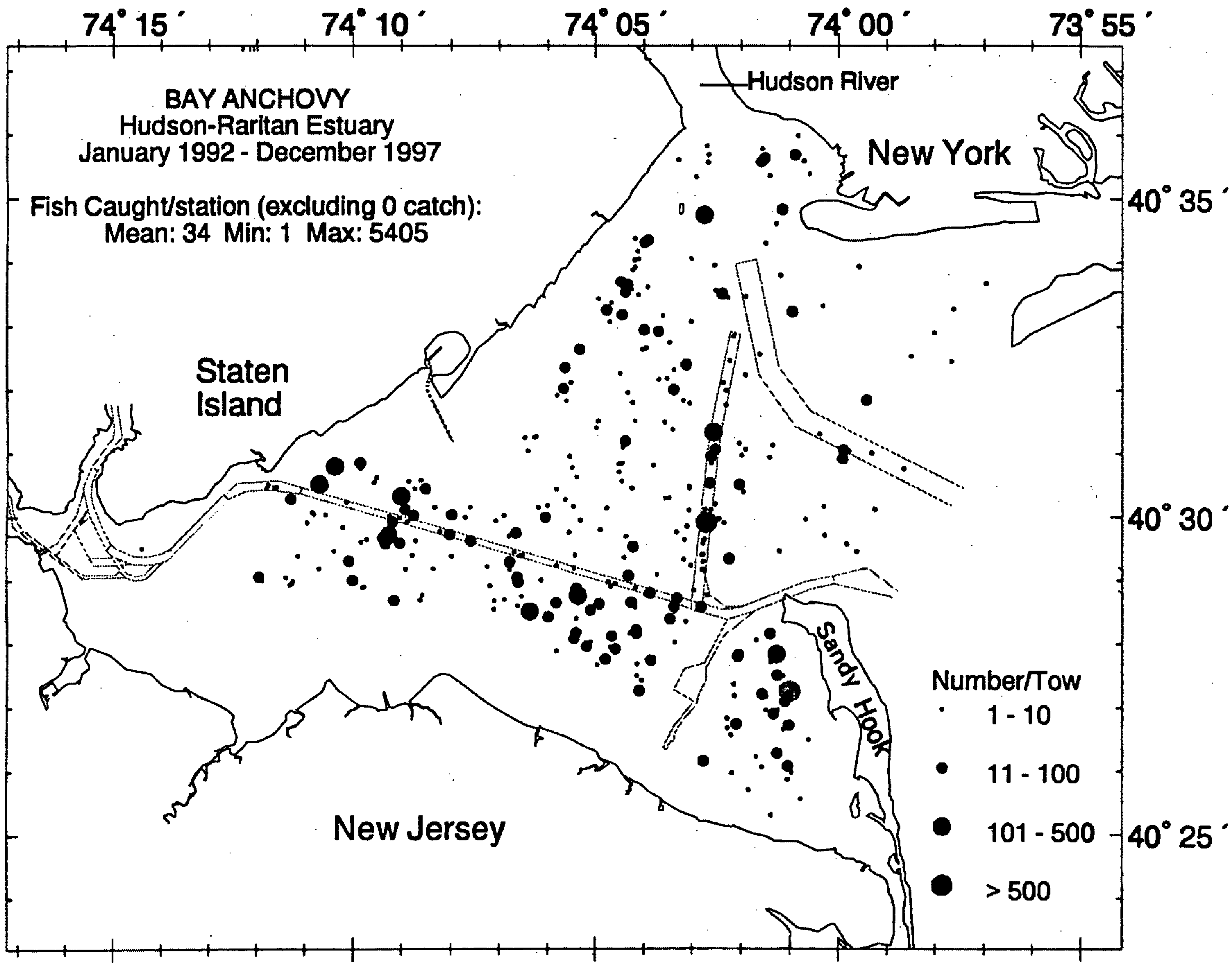

Figure 24. Bay anchovy distribution and relative abundance in Hudson-Raritan Estuary, 1992-97 (Wilk et al. 1998).