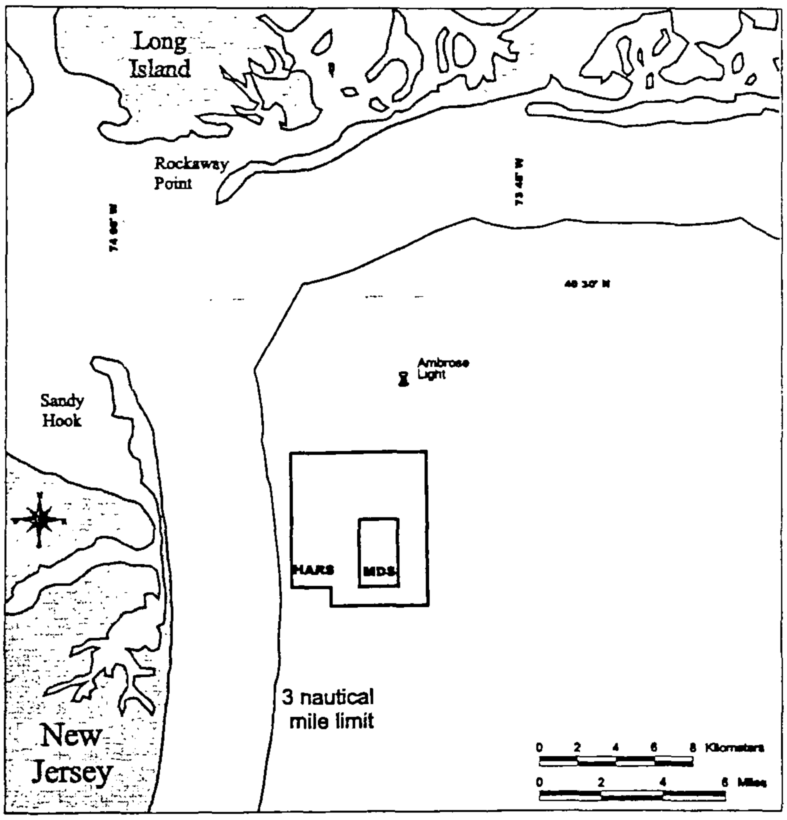
Biological Assessment for the Closure of the Mud Dump Site and Designation of the Historic Area Remediation Site in the New York Bight Apex

MAY 1997



U.S. Environmental Protection Agency, Region 2
290 Broadway, New York, NY 10007-1866

MAY 30 1997

Mr. Christopher Mantzaris, Chief
Habitat & Protected Resources
National Marine Fisheries Service
1 Blackburn Drive
Gloucester, Massachusetts 01930

Dear Mr. Mantzaris:

On April 4, 1996, the Environmental Protection Agency (EPA), pursuant to Section 7 of the Endangered Species Act (ESA), initiated informal consultation with the National Marine Fisheries Service (NMFS), concerning the possible presence of federally listed threatened /endangered species in the vicinity of the Mud Dump Site (MDS) and surrounding areas in the New York Bight. This informal consultation was conducted as part of our preparation of a Supplement to the Environmental Impact Statement on the New York Dredged Material Disposal Site Designation for the Designation of the Historic Area Remediation Site (HARS) in the New York Bight Apex (enclosed).

Based on the May 8, 1996 NMFS response to EPA's April 1996 letter, and discussions between our two staffs, the EPA has prepared a Biological Assessment (BA) of the potential impacts of the proposed action on the loggerhead, and Kemps ridley sea turtles, and humpback and fin whales. The BA (two copies enclosed), utilizes information that has been provided by NMFS, in conjunction with a variety of EPA reports and other reference material. The BA also considers surveys and studies of the New York Bight Apex that have been conducted over the past two years by EPA and the U. S. Army Corps of Engineers. Based on the BA, the EPA has determined that the proposed designation of the HARS in the New York Bight Apex is not likely to adversely affect the aforementioned listed species. Accordingly, I request the NMFS's written concurrence with this determination within 30 days, pursuant to 50 CFR Part 402.12(j).

In the interim, should you have any questions concerning the BA or our determination, please contact me or Joseph Bergstein of my staff.

Sincerely yours,

Robert W. Hargrove, Chief
Strategic Planning & Multi-Media Programs Branch

Enclosure

cc: M. Ludwig, NMFS Milford

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BIOLOGICAL ASSESSMENT
FOR THE CLOSURE OF THE MUD DUMP SITE AND DESIGNATION OF THE HISTORIC AREA REMEDIATION SITE IN THE NEW YORK BIGHT APEX

EPA Contract No. 68-C7-0004
Work Assignment 0-04

to

U.S. Environmental Protection Agency
Region 2
New York City, NY

May 28, 1997

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDIX

Introduction
The Port of New York and New Jersey is one of the nation's leading ports. To maintain this deepwater port, dredging of its waterways is necessary on a periodic basis. Currently, material dredged from the Port that is classified as Category I and II is disposed in the New York Bight Apex at the Mud Dump Site (MDS), located approximately 5.3 nmi east of Sandy Hook, NJ and 9.6 nmi south of Rockaway Beach, Long Island, NY.

Over the last few years, monitoring studies have found degraded sediment which exhibits potentially toxic and bioaccumulative contaminants in the surface sediments of the MDS and adjacent areas. Additionally, benthic infauna and lobsters in the MDS area have bioaccumulated contaminants which can potentially impact higher trophic organisms, including human beings. The extent of the degraded sediment areas of the Bight Apex, and the potential impacts presented by the historical use of the MDS, led EPA to propose the closing of the MDS and designation of the Historic Area Remediation Site (HARS).

Section 7 of the Endangered Species Act of 1973 (ESA; P.L. 93-205) requires that Federal agencies' actions not jeopardize the existence of endangered or threatened species or result in destruction or adverse modification of the critical habitat for such species. In accordance with the ESA, EPA has coordinated with the National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS) to ensure that designation and management of the HARS does not adversely affect any protected species or critical habitat. This Biological Assessment (BA) is a result of EPA's coordination with the NMFS; EPA's informal consultation with the USFWS was concluded on July 28, 1995.

Two species of endangered great whales (humpback and fin whales) and two species of threatened or endangered sea turtles (loggerhead turtle and Kemp's ridley turtle) visit coastal waters of the New York Bight on a seasonal basis to feed. These species, which are the focus of this BA, may pass through the HARS and the shipping lanes used to transport the material for remediation to the site. The material for remediation (hereafter: Material for Remediation or Remediation Material) is defined as:
". . . uncontaminated dredged material (i.e. dredged material that meets current Category I standards and will not cause significant undesirable effects including through bioaccumulation)."

Proposed Action and Alternatives
The Proposed Action is to close (de-designate) the existing 7.5-km^2 (2.2-nmi^2) MDS and simultaneously designate a 54-km^2 (15.7-nmi^2) HARS. Designation of the HARS will allow for the remediation of degraded sediments. The degraded sediments in the HARS will be remediated by placement of at least a 1-m cap of Material for Remediation. The Proposed Action to designate the HARS for remediation of degraded sediments is the most environmentally acceptable and economically feasible alternative evaluated by EPA.

BA Proposed Action (SEIS Alternative 3): HARS Remediation
- Simultaneous closure of the MDS and designation of 15.7-nmi^2 (54-km^2) HARS
- The HARS is composed of the Priority Remediation Area (PRA), a Buffer Zone (BZ), and No Discharge Zone (NDZ), including the MDS and sediments that have toxicity or bioaccumulative contaminants.
- Remediation conducted by capping degraded sediment areas with at least 1 m of Material for Remediation
- Approximately 40.6 Myd^3 required to remediate the 9.0-nmi^2 (31-km^2) PRA; actual placement volume may be larger to ensure at least a 1 m cap throughout the PRA
- Remediation work prioritized by degree of sediment degradation

In addition to the Proposed Action, there are three alternatives:

BA Alternative 1 (SEIS Alternative 1): No Action

- No change to size or management of the present Mud Dump Site (MDS)
- No remediation of areas outside of the MDS with toxicity or sediments degraded by bioaccumulative contaminants, or restoration of fine-grain sediment areas
- Disposal of Category I dredged material continues per the MDS Site Management and Monitoring Plan (SMMP) until current remaining disposal capacity is reached
- Category II dredged material capacity will be reached by September 1, 1997

BA Alternative 2 (SEIS Alternative 2): Close MDS-No HARS Designation

- Closure of the present Mud Dump Site
- No Historic Area Remediation Site (HARS) designated
- No remediation of sediments outside of the MDS with toxicity or sediments degraded by bioaccumulative contaminants, or restoration of fine-grain sediment areas created by past dredged material disposal

BA Alternative 3 (SEIS Alternative 4): HARS Restoration

- Simultaneous closure of the MDS and designation of 15.7-nmi^2 (54-km^2) HARS
- The HARS is composed of the PRA, NDZ, and BZ, including the MDS, surrounding areas that has been historically used for disposal of dredged material and other wastes (e.g., building materials, sewage sludge, industrial wastes), and sediments degraded by bioaccumulative contaminants or toxicity.
- Restoration work conducted by covering fine-grain sediment areas with at least 1 m of sandy (0-10% fines) Material for Remediation
- Approximately 46.4 Myd^3 required to restore the 10.3 nmi^2 (35.5 km^2) of fine-grained sediments in the PRA; actual placement volume may be larger to ensure at least a 1 m cap throughout the PRA
- Restoration work prioritized by degree of sediment degradation

Affected Environment

For its evaluation of the MDS and the surrounding area of the New York Bight Apex, EPA selected a Study Area based on field data indicating historical dredged material disposal and evidence of sediment toxicity and the presence of contaminants. The Study Area was the basis for all subsequent evaluations used in the development of this BA and EPA's Supplement to the Environmental Statement on the New York Dredged Material Disposal Site Designation for the Designation of the Historic Area Remediation Site (HARS) in the New York Bight Apex (hereafter referred to as the SEIS).

The Study Area is located in the New York Bight Apex, east of Sandy Hook, NJ, south of Rockaway Beach, NY, and southeast of the entrance to the Port of New York and New Jersey. Water depths in this area range from 12 to 42 m.

Within the Study Area, which includes the MDS, bottom sediments are heterogeneous and composed of muds, clays, sands, and occasional rock outcrops and shipwrecks. Degraded sediments in the HARS are contaminated by both metals and organic contaminants. The EPA Region 2 SEIS provides summary data that characterizes the sediments throughout the Study Area. The SEIS concludes that while it is impossible to quantify how much of New York Bight Apex contamination is the direct result of past dredged material disposal, other ocean dumping activities (e.g., former sewage sludge disposal at the 12-Mile Site), or other sources (e.g., via Hudson River plume or atmospheric deposition), the presence of these dredged sediments in the Apex is cause for concern.

Water quality throughout the New York Bight Apex is generally good. It has improved substantially following cessation of disposal of sewage sludge in the Bight Apex and implementation of effluent limitations for domestic and industrial wastewater effluents to the Hudson/Raritan River estuary system. Present discharges of Category I and Category II dredged materials at the MDS have only minor, transitory effects on water turbidity and do not result in significant increases in concentrations of chemical contaminants and primary nutrients in the water column. Concentrations of dissolved oxygen in bottom waters are generally high and have improved substantially after cessation of sewage sludge dumping in the Bight Apex in 1987.

Mean ocean currents through the Study Area are toward the southwest, parallel to the local depth contours. Current speeds increase with distance from shore and decrease with depth. In the short-term, local currents are modified by tidal and wind forcing. The wind stress tends to be directed offshore during the winter when wind velocity is highest. Strong winter storms can produce strong along-shelf currents. Maximum recorded wave heights during storms are more than 7 m, sufficient to resuspend sediments within the shallower areas of the present MDS. Resuspension and transport of sediments usually are either to the north in the Hudson Shelf Valley or southward out of the Bight.

The New York Bight has a moderately high biological productivity. Primary production by phytoplankton in surface waters is highest in spring and early summer and is lowest in late fall and winter. The relative abundance of zooplankton in the Bight tracks that of phytoplankton with a one to two month delay.

Benthic and swimming crabs, the preferred prey of loggerhead and ridley turtles, are abundant in shallow nearshore waters and bays of the New York Bight, particularly along the southern and eastern shores of Long Island. These crustaceans are most abundant in coastal waters during the summer.

Small schooling fish, such as herring and mackerel, and near-bottom forage fish, such as sand lance, serve as preferred prey for humpback and fin whales in the New York Bight. These fish are migratory and are most abundant in shelf and nearshore waters of the Bight in different seasons. Herring may be abundant in nearshore waters in the spring, mackerel in the spring and fall, and sand lance during the summer. In recent years, the herring, mackerel, and sand lance stocks in the New York Bight have increased. Similar increases of forage fish have been observed in New England waters, resulting in a shift in the summer distribution of humpback and fin whales in the Gulf of Maine.

Several species of marine or coastal birds live in or on the shores of the New York Bight. Three of these, the bald eagle, the piping plover, and the eastern peregrine falcon, are threatened or endangered. The piping plover feeds on intertidal invertebrates and the peregrine falcon feeds primarily on small birds. Bald eagles are opportunistic predators that prefer fish (dead or live). The northeastern tiger beetle, which inhabits coastal areas, is present within 3.5 nmi of the Study Area. Concerns regarding potential impacts to the piping plover and northeastern tiger beetle were resolved during EPA-USFWS consultation.

Natural History of Whales and Sea Turtles in the New York Bight

Humpback Whale (*Magaptera novaealgleae*). The estimated current total population of humpback whales in the western North Atlantic Ocean, including the New York Bight, is 5,543 individuals. The western North Atlantic stock winters off the Lesser and Greater Antilles Islands in the eastern Caribbean Sea. During the summer, these whales split into five feeding aggregations that migrate to and feed along the coasts of Iceland, southwestern Greenland, Newfoundland and Labrador, the Gulf of St. Lawrence, and the Gulf of Maine. Most of the humpbacks that visit the New York Bight probably are from the Gulf of Maine feeding aggregation, which numbers about 450 individuals.

Between 50 and 100 humpback whales are observed each year in the New York Bight. All age classes, including mother/calf pairs are present in the Bight between June and September. In the winter, all the humpback whales sighted in the New York Bight are non-reproducing juveniles.

Humpback whales visit the New York Bight in all seasons to feed on small forage fish and euphausiid crustaceans. The whales are observed most frequently in coastal waters of eastern Long Island. There have been only a few sightings of humpbacks near the MDS and proposed HARS. The distribution of humpback whales in the Bight may change as the relative abundance and distributions of their preferred prey changes.

The most common anthropogenic source of injury and mortality for humpback whales in the western North Atlantic is entanglement in fishing gear. Collisions with vessels, particularly large ships, also are a common source of injury and death for the whales. Humpback whales along the U.S. Atlantic coast have become quite tolerant of small boat traffic and do not appear to be markedly disturbed by physical and acoustic disturbance from these vessels.

Humpback whales are the top consumers in a relatively simple, short food chain composed of phytoplankton, zooplankton, and small forage fish. The main route for bioaccumulation of chemical contaminants is by trophic transfer through this food chain. Of the limited chemical-residue data sets available, organochlorine compounds in blubber and organ tissues of humpback whales from the western North Atlantic are somewhat elevated, over those of humpback whales from other areas. In comparison, contaminant concentrations in toothed whales are significantly higher than in humpbacks. In all cases, contaminant concentrations in humpback whales are lower than levels associated with adverse effects in marine mammals.

Fin whale (*Balaenoptera physalis*). Fin whales are long slender whales that are capable of rapid swimming speeds. They were less depleted by whaling than most other species of great whales. An estimated 5,000 fin whales occupy continental shelf waters between Cape Hatteras and the Canadian border each spring and summer. Several thousand additional fin whales occupy Canadian Atlantic waters in the summer and frequently visit U.S. waters. While the summer distribution of Atlantic populations of fin whales overlaps that of humpback whales, fin whales are more widely distributed in the Middle-Atlantic Bight. Large numbers of fin whales remain in northern waters during the winter, compared to humpbacks which predominately overwinter in southern waters.

Fin whales are the most abundant baleen whales in the New York Bight and can be sighted year-round. In January through March, they are found close to shore off eastern Long Island where they probably are feeding on herring and mackerel. They also appear in relatively large numbers in the New York Bight Apex in the winter. They tend to move offshore and to northern feeding grounds to feed in the spring and summer. Fin whales that winter further south visit the New York Bight, particularly waters off eastern Long Island, during the summer. All age classes, including mother/calf pairs, visit the Bight during the year. The distribution of fin whales in the Bight has changed somewhat in recent years, probably reflecting changes in the distribution of their prey.

Like humpback whales, fin whales feed on small forage fish and euphausiid shrimp; the two species often are seen feeding together, particularly where schools of sand lance are abundant. In the New York Bight, fin whales sometimes are observed feeding on dense patches of pelagic euphaudiid crustaceans.

Fin whales, like humpbacks, frequently become entangled in fishing gear. However, unlike humpbacks, fin whales are better able to avoid collisions with large vessels because of their great speed. Fin whales have also been shown to bioaccumulate anthropogenic contaminants, such as polychlorinated biphenyls (PCBs) and DDT.

Loggerhead turtle (*Caretta caretta*). Loggerhead turtles are threatened throughout their range. Approximately 378,000 loggerheads live in coastal waters of the southeastern United States. An estimated 7,000 to 10,000 individuals, mostly subadults of both sexes, visit coastal waters of the middle and north Atlantic during the summer to feed.

Juvenile loggerhead turtles are abundant during summer months in coastal waters of the New York Bight. In the fall, they migrate southward to coastal waters of the south Atlantic states, particularly Florida, where they spend the winter. The turtles feed in shallow coastal waters in Long Island Sound, Gardners Bay, the south shore of Long Island, and the Hudson/Raritan Estuary during the summer. Occasionally, they are trapped and cold-stunned (and killed) by rapidly falling water temperatures in Long Island Sound and the bays of eastern Long Island during the fall. The young turtles grow rapidly during their summer visits to the New York Bight.

In New York coastal waters, loggerheads feed on the bottom, primarily on small crabs. Feeding depths are almost exclusively <20 m. When feeding, loggerheads often spend more than 57 minutes of each hour below the water surface.

Several loggerheads strand on the shores of New York and New Jersey each year, most often from cold-stunning in the fall. In the New York Bight area, the second major cause of death of loggerhead turtles is collisions with vessels. Further south, large numbers of loggerheads are killed annually by entrapment or entanglement in active fishing gear, particularly shrimp and fish trawls. Ingestion or entanglement in floating debris, particularly monofilament fishing lines and floating plastic are a major source of injury and death for loggerheads. Hydraulic dredging operations (not disposal) also contribute to annual mortalities. Winter dredging of the Cape Canaveral channel, Florida, and King's Bay, Georgia, has resulted in the deaths of sea turtles that hibernate in dredging areas. Because loggerheads do not hibernate in New York-New Jersey Harbor or surrounding areas, dredging operations do not impact resident turtles.

Kemp's ridley turtle (*Lepidochelys kempi*). Kemp's ridley turtle is the most severely endangered sea turtle in the world. The entire Atlantic population probably does not exceed 500 adult animals. The total world population of adult, breeding ridleys, mostly in the Gulf of Mexico, is approximately 2,200 individuals. There probably are 10 to 50 times as many juveniles, bringing the total population to 22,000 to 110,000 turtles of all ages. Only juvenile ridleys migrate into and feed in middle and north Atlantic coastal waters.

Virtually all the ridley turtles that visit the New York Bight during summer to feed are juveniles. These juveniles, 20 to 30 cm long, begin arriving in New York waters each year in July or August and remain in shallow waters, particularly in the bays of eastern Long Island until mid to late September. They then migrate southward toward wintering areas along the U.S. south Atlantic coast. Ridleys migrating south from further east and north may become trapped by rapidly declining water temperatures and strand along the shores of eastern Long Island and in Long Island Sound.

Ridleys, like loggerheads, feed primarily on small crabs that they capture in shallow coastal waters. They rarely feed in water deeper than about 15 m. The juvenile turtles grow rapidly during their brief summer visits to the New York Bight. There is growing evidence that, despite their small size, the juvenile ridleys are able to make the long migration from New York and New England waters south to the Gulf of Mexico where they join the only breeding population.

Kemp's ridley turtles are sensitive to cold stunning. Several turtles wash ashore stunned or dead each fall as water temperatures fall rapidly along the shores of Long Island Sound and the New York Bight. The main cause of anthropogenic mortality of ridleys in the New York Bight area appears to be vessel strikes. Farther south large numbers of juvenile ridleys are caught and killed in shrimp nets. As many as 5,000 juvenile and adult ridleys are killed by entrapment in shrimp nets each year, far greater than the estimated numbers killed by vessel strikes in the New York Bight area. Because they feed on the bottom, they sometimes become trapped in bottom fishing gear, such as lobster and crab traps.

Impacts of the Proposed Action

Between 1990 and 1996, 26 million cubic yards (Myd^3) of dredged material was dumped at the current MDS. There was an average of 829 barge trips per year, each delivering an average of approximately 4,645 yd^3 of dredged material. Under the Proposed Action, an estimated 40.6 Myd^3 of Material for Remediation would be placed in the HARS during remediation operations providing a 1-m cap of Material for Remediation. It is expected that the number of barge trips to the HARS under the Proposed Action will be considerably less than the 1990-1996 annual average number of trips to the MDS.

Placement of at least 1 m of Material for Remediation in the Priority Remediation Area (PRA) of the HARS will cover and isolate all degraded sediments of the HARS. During placement operations, there will be temporary increases in turbidity in the water column as suspended fine-grain sediments disperse from the dredged material plume. However, these plumes will not exceed marine water quality criteria after initial mixing and will fully dissipate within about 1 h of discharge.

Because all Material for Remediation placed in the HARS will have passed toxicological and bioaccumulation tests, no contaminant-associated impacts will occur. Because the Material for Remediation will not contain significant levels of contaminants, it is extremely unlikely that the Proposed Action will adversely impact the food chain of the endangered and threatened turtles and whales in the area. Correspondingly, capping the degraded sediment areas with at least 1 m of Remediation Material will decrease contaminant exposure to the turtles and whales, and the Proposed Action will decrease the risk for whales and turtles to ingest contaminated prey.

Remediation of the HARS will decrease the water depth of the site by approximately 1 m. If the Material for Remediation has a different texture or mineralogical composition of the current sediments in the area, sediment texture and other physical properties of surficial sediments will change. Concentrations of bioavailable and potentially toxic forms of inorganic and organic chemical contaminants in surface sediments will decrease; however, the effects of these reductions may not be measurable in whale and turtle prey.

Although the Proposed Action may affect the bottom habitat and the corresponding communities (within the PRA and Buffer Zone of the HARS), there is unlikely to be any effects on the endangered species or their critical habitat. Preferred prey species of the four threatened or endangered species occur but are not known to be abundant within the HARS. In general, water depths at the HARS are greater than the preferred foraging depth of the sea turtles, and humpback and fin whales have never been observed feeding in the vicinity. In summary, the protected turtles and whales are unlikely to forage in the HARS. The potential for turtles and whales to bioaccumulate contaminants from prey organisms before remediation operations is very low and this potential will be further reduced after completion of remediation operations.

The number of barge trips per year to the HARS is expected to be substantially fewer than the 829 trips per year average to the MDS for 1990 to 1996. Potential disturbance to endangered whales and turtles from ambient noise, or injury or death from collision is thus expected to be less than current conditions.

The underwater noise of under-way loaded barges and tug boats, although loud, will not significantly change the current level of anthropogenic noise in waters of the New York Bight Apex. Commercial and recreational vessel traffic in the northwestern Bight is very high and barges/tugs make only modest additions to overall ambient noise.

Barges are towed at low speeds, usually less than 6 knots, and will be manned with NMFS-certified observers to spot and help avoid collisions with whales and sea turtles. Given the slow movement of the vessels, and the presence of the observers, the risk of collisions between barges carrying Material for Remediation and endangered whales and sea turtles is very low.

The average number of trips per year to the HARS under the Proposed Action (SEIS Alternative 3), BA Alternative 1, and BA Alternative 3 are less than the current annual trips to the MDS. While the estimated annual number of trips to the HARS under the Proposed Action and BA Alternative 3 are similar, BA Alternative 3 will take considerably longer to fully implement.

Relative to the potential bioaccumulation impacts from degraded sediments, the Proposed Action presents less impact than BA Alternatives 1, 2, and 3 (SEIS Alternatives 1, 2, and 4, respectively). However, the degree of impact reduction is likely to be undetectable with the limitations of current measurement technology and the natural variability of the benthic ecosystem in the Bight Apex. Under BA Alternative 1, degraded sediment exhibiting Category II or III characteristics inside the current MDS will be capped and isolated from the ecosystem, and thereby reduce contaminant bioaccumulation potential. Outside the MDS, however, equivalent sediments under BA Alternative 1 will not be capped and will continue to expose the benthic organisms to bioaccumulative contaminants and sediment toxicity. Similarly, under BA Alternative 2, none of the degraded sediments within the MDS or surrounding environs will be remediated. Under BA Alternative 3, degraded sediments throughout the MDS and environs will eventually be capped, however, the ecosystem will continue to be exposed to the contaminants during the lengthy period expected for the restoration operations to be implemented and completed.

1.0 INTRODUCTION

The Port of New York and New Jersey is one of the nation's leading ports. With 126.1 million short tons shipped in 1994, the Port ranked third, behind only the Port of South Louisiana and the Port of Houston, which shipped 184.9 and 143.7 tons, respectively (USACE WCSC, 1996). To maintain this deepwater port, dredging of its waterways is necessary on a periodic basis. All sediment dredged from this port is evaluated and categorized by Environmental Protection Agency (EPA) Region 2 and the U.S. Army Corps of Engineers (USACE) New York District (NYD) prior to determining a disposal method and site. The nearest ocean disposal site serving the Port of New York and New Jersey is the Mud Dump Site (MDS), located approximately 5.3 nmi off Sandy Hook, NJ and 9.6 nmi off Rockaway Beach, Long Island, NY (Figure 1).

Over the last few years, monitoring studies have found toxicity and potentially bioaccumulative contaminants in the surface sediments of the MDS. These contaminants are associated with degraded sediments [as defined in Chapter 3 of the Supplemental Environmental Impact Statement (SEIS); EPA Region 2 (1997)] and are probably the result of dredged material disposed prior to 1991, when dredged material tests for ocean disposal were revised. In addition, 1994 sediment data from outside the borders of the MDS revealed "hot spots" of degraded sediments north, east, west and northwest of the MDS. These other contaminated areas were probably caused by either dredged material disposal projects completed before the 1973 interim designation of the MDS, other ocean dumping in the Bight Apex (e.g., sewage sludge dumping), or are the result of current or historic Hudson River outflow or atmospheric deposition contamination.

EPA selected a Study Area in the New York Bight Apex that was the basis for evaluations used in the SEIS and this Biological Assessment (BA). Subsequent to the evaluations and Agency decision making, EPA has proposed designating a Historic Area Remediation Site (HARS) that encompasses approximately one-half of the Study Area. The HARS would be 15.7 nmi^2 (54 km^2) and include the entire current MDS area (Figure 1). Within the HARS would be a 9.0-nmi^2 (31-km^2) Priority Remediation Area (PRA), a 500-m Buffer Zone (BZ), and a No Discharge Zone (NDZ).[1] Following its designation, the HARS would be managed to allow for remediation of the degraded sediment areas. This BA focuses on activities associated with placement of Material for Remediation[2] in the HARS as it relates to specific endangered and threatened species.

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[1]The Priority Remediation Area (PRA) is 9.0-nmi^2 area that is divided into nine 1-nmi^2 cells for management purposes. The PRA contains the degraded sediments found in the MDS and surrounding areas, and will be covered with at least 40.6 Myd^3 of Remediation Material to ensure at least a 1-m cap throughout the area. The areas exhibiting the greatest relative degree of degradation will be remediated first. The Buffer Zone (BZ) is an approximately 5.7-nmi^2 area (500-m, 0.27-nmi-wide band around the PRA) in which no placement of Remediation Material will be allowed, but may receive Remediation Material that incidentally spreads out of the PRA. The No Discharge Zone (NDZ) is an approximately 1.0-nmi^2 area in which no placement or incidental spread of Material for Remediation will be allowed. The NDZ is not degraded, and is generally above the 20-m (approx. 65-ft) depth contour, the depth at which large storms such as hurricanes and northeasters are able to generate sufficient water turbulence to resuspend and transport benthic sediments.

[2]Material for Remediation (Remediation Material) is defined as: ". . . uncontaminated dredged material (i.e. dredged material that meets current Category I standards and will not cause significant undesirable effects including through bioaccumulation)." (July 24, 1996, EPA/DOT/USACE 1996)

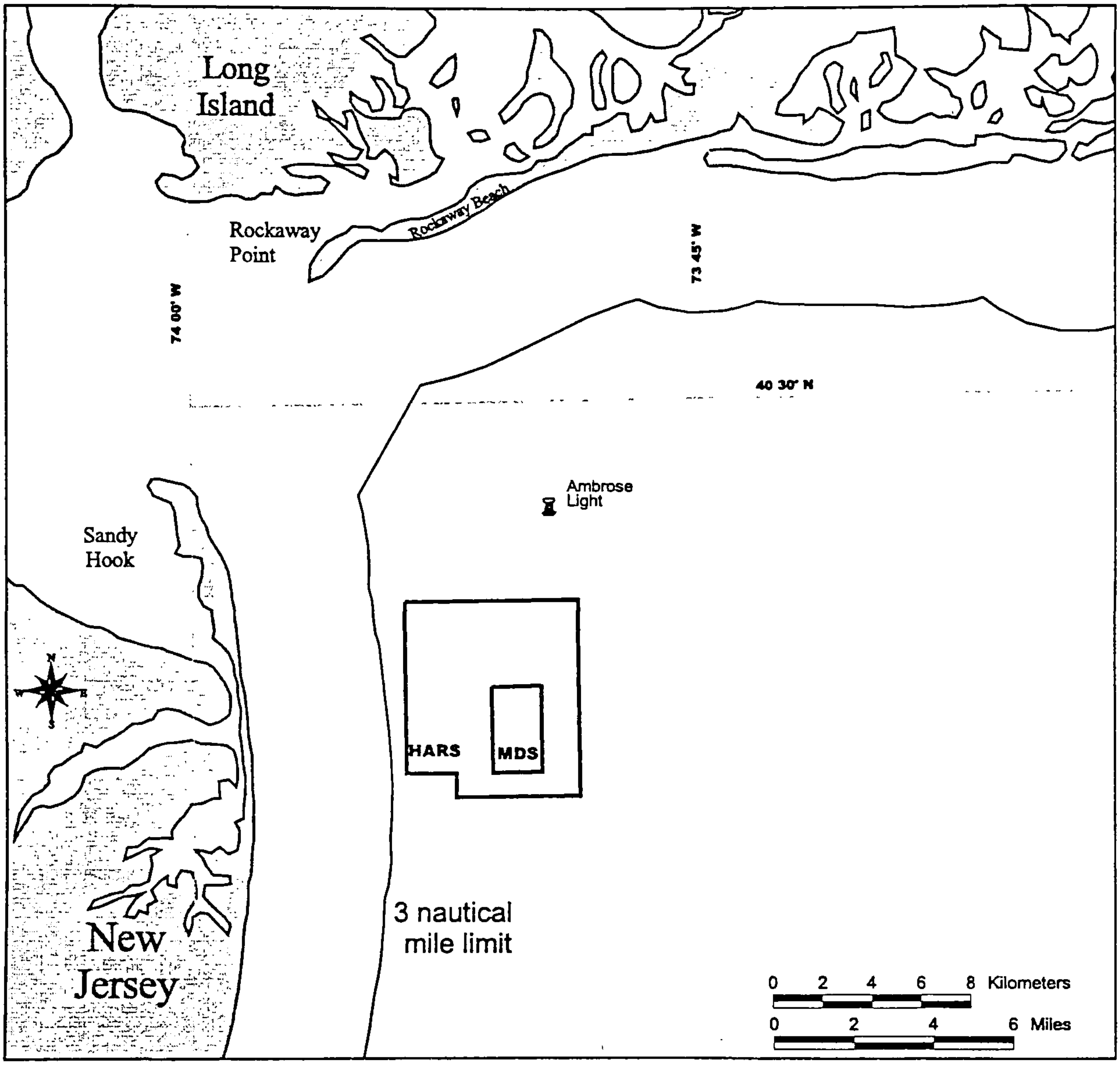

Figure 1. Location of Current Mud Dump Site (MDS) and the Historic Area Remediation Site (HARS).

1.1 Endangered Species Act Regulations

This BA was prepared in accordance with Section 7 of the Endangered Species Act of 1973 (ESA, P.L. 93-205) which requires that all Federal agencies ensure that any action they authorize, fund, or carry out will not jeopardize the continued existence of any endangered or threatened species (i.e., listed species) or result in the destruction or adverse modification of any critical habitat of such species. The "action" under consideration is the closure of the present MDS and designation of the HARS as a site for subsequent placement of Material for Remediation so as to remediate degraded sediment areas.

Because the action will occur in marine waters, the ESA mandates that the Federal agency responsible for the "action" (i.e., EPA) consult with the Department of Commerce. Consultation with the Secretary of Interior is required also if any birds or other non-marine endangered or threatened species may be affected by the action. Accordingly, EPA consulted with the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) to ensure that the proposed action does not ". . . jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of the critical habitat of such species" (50 CFR Part 402). This consultation includes preparation of a Biological Assessment (presented herein) to determine if designation of the HARS is likely to result in adverse effects to threatened or endangered species.

With respect to EPA's coordination with the USFWS, potential issues concerning species (e.g., piping plover, northeastern tiger beetle) under the jurisdiction of the USFWS were resolved during an informal consultation that concluded on July 28, 1995.

1.2 Endangered Species Considered

This BA was developed to determine if designation of the HARS and subsequent conveyance to and placement of Material for Remediation at the HARS in the New York Bight Apex could have adverse effects on the marine ecosystem and biological resources of the Apex. Particular concern is for endangered species of marine animals that may reside in or visit the area of the HARS and the barge routes between the Port of New York and New Jersey and the HARS. Six species of endangered great whales (right, humpback, fin, sei, blue, and sperm whales) and five species of threatened or endangered sea turtles (loggerhead, Kemp's ridley, leatherback, green, and hawksbill turtles) are permanent or seasonal residents of coastal and ocean waters of the western North Atlantic, including the New York Bight Apex. Only four of these threatened or endangered species are regular visitors to coastal waters of the New York Bight Apex and might visit the HARS during feeding or migration. These are humpback whales, fin whales, loggerhead turtles, and Kemp's ridley turtles. These animals all visit the New York Bight to feed on a seasonal basis. Based on recommendations by the NMFS, EPA has assessed the potential impact of placement of Material for Remediation in the HARS on the four above-mentioned species.

EPA has conducted an informal consultation with the U.S. Fish and Wildlife service (U.S. Fish and Wildlife Service Letter dated April 6, 1995) for endangered species under its jurisdiction within the HARS (including marine and coastal birds and northeastern tiger beetle). This informal consultation was concluded on July 28, 1995.

1.3 Format of the BA

The BA is a key component of the ESA §7 consultation procedure for designation of the HARS. This BA will provide background information on the affected environment or "action area." This background information includes a description of the physical, biological, and chemical features of the New York Bight Apex. In addition, descriptions of the natural histories of endangered or threatened species present in the area are presented.

As stated above, the proposed HARS and the New York Bight Apex are the focus of this BA. The endangered and threatened species (i.e., listed species) that are discussed in this BA have been approved by the NMFS during the early stages of the consultation (NMFS letter dated May 8, 1996 from NMFS to EPA). The information on the affected environment and the endangered species natural histories in this report is used to (1) evaluate the potential effects to endangered and threatened species and designated critical habitats by the designation of the HARS and subsequent placement of Material for Remediation, and (2) determine whether any listed species are likely to be adversely affected by the action. Alternatives to the Proposed Action will be presented and evaluated with respect to their potential to minimize impacts to the endangered and threatened species.

This BA uses information presented in the Biological Opinion issued on May 12, 1993 by the National Marine Fisheries Service for the Port Elizabeth/Port Newark Dredging and Ocean Disposal Project (Port Authority Project)(USACE 1993). The Biological Opinion addressed potential effects of activities at the MDS on six endangered (right whale, fin whale, humpback whale, leatherback turtle, Kemp's ridley sea turtle, and the green turtle) and one threatened (loggerhead turtle) species. The four endangered and threatened species (fin whale, humpback whale, Kemp's ridley turtle, and loggerhead turtle) requested by the NMFS (as noted in the NMFS May 8, 1996 letter to EPA) are included in this BA. Thus information and data presented in the Biological Opinion on these four species is incorporated in this BA, where appropriate.

2.0 AFFECTED ENVIRONMENT

This chapter of the BA provides a description of the physical (e.g., benthic topography), chemical (e.g., water temperature), and biological (e.g., fish species) characteristics of the New York Bight in general and the Study Area, in particular, when possible. The Study Area is a 30-nmi^2 area surrounding the current MDS; the HARS encompasses approximately one-half of the Study Area (refer to Figure 1). Environmental variables such as benthic topography (Evans 1975, Hui 1979), fronts and mixing regimes (Volkov and Moroz 1977), sea surface temperature (Au and Perryman 1985), and sea surface salinity (Thomson *et al.* 1986) may be related to the distribution of cetaceans and sea turtles. This chapter is not intended to provide a comprehensive physical, chemical, and biological characterization of the New York Bight. Rather, it provides an overview of the environment of the Study Area.

Much of the information presented in this chapter has been summarized from the SEIS that has been prepared by EPA pursuant to the National Environmental Policy Act (NEPA). Readers are encouraged to refer to referenced literature of this BA and the SEIS (EPA Region 2 1997) for more detailed information on the affected environment of the current MDS, and the environmental consequences of the Proposed Action to designate a HARS.

2.1 Physical Environment

The following description of the physical environment of the HARS, inner New York Bight or Apex, and the greater New York Bight provides a basis for understanding the oceanographic processes that make these areas desirable as habitat for endangered and threatened species and their prey (e.g., zooplankton, fish, and benthic invertebrates).

The current MDS, the Study Area, and the proposed HARS are located in the inner New York Apex (Figure 1). The Bight Apex is the northwest corner of the larger New York Bight, which covers approximately 2,000 km^2 in the Northwest Atlantic Ocean bounded by Long Island, NY to the north and the New Jersey coast to the west and the continental slope to the east. The New York Bight has several unique physical and ecological features which differentiates it from neighboring coastal waters. Aspects of the physical environment of the MDS, Study Area, HARS, and New York Bight are discussed below.

2.1.1 Topography

The Study Area is located on the shoulder of the drowned Hudson River Valley of the New York Bight Apex, west of the Christiaensen Basin. Most of the area is depositional, receiving sediments from the Hudson River estuary via the Hudson River plume and eastward areas via a seasonally variable anticyclonic gyre (NOAA 1988).

Topography of the Study Area is dominated by the dredged material mound deposited over the past 100 years. Historical records of ocean dumping in the Bight Apex indicate that solid waste, including dredged material, disposal in the New York Bight has resulted in a continual filling of the Hudson River Valley from just outside the New York Harbor to areas beyond the southernmost boundary of the present MDS. Disposal activities have altered the bottom topography such that a distinct ridge of dredged material extends through the Study Area from the northwest to the southeast. A topographic low is evident to the west of this dredged material disposal mound. This topographic low was not present historically and is the direct result of the disposal activity that has been focused along the axis of the Hudson River Canyon. To the east of the ridge of dredged material, depths rapidly increase into the Hudson Shelf Valley.

2.1.2 Water Depths

Water depths in the New York Bight gradually increase from 12 m near the mouth of the New York Harbor to 200 m at the continental shelf break. The major geological feature in the New York Bight is the Hudson Shelf Valley that extends across the bight from the New York Harbor to offshore.

Water depths in the Study Area are shallowest over the dredged material mound, ranging from 12 to 16 m along the mound axis. The average depth of the present MDS is 22 m. The water depth within the proposed HARS ranges from 12 to 42 m. Water depths in the eastern third of the northern half of the Study Area rapidly increase seaward from the mound axis. Depths of 26 m exist along the central north-south axis of the Study Area and increase to approximately 40 m at the eastern boundary. Depths increase seaward across the southern third of the Study Area from 22 m in the Shewsbury Rocks area to 40 m in the Hudson Shelf Valley. The shallow valley to the west of the dredged material mound is approximately 26 m at its deepest extent and shoals to depths of less than 22 m in the center of the area (Figure 2).

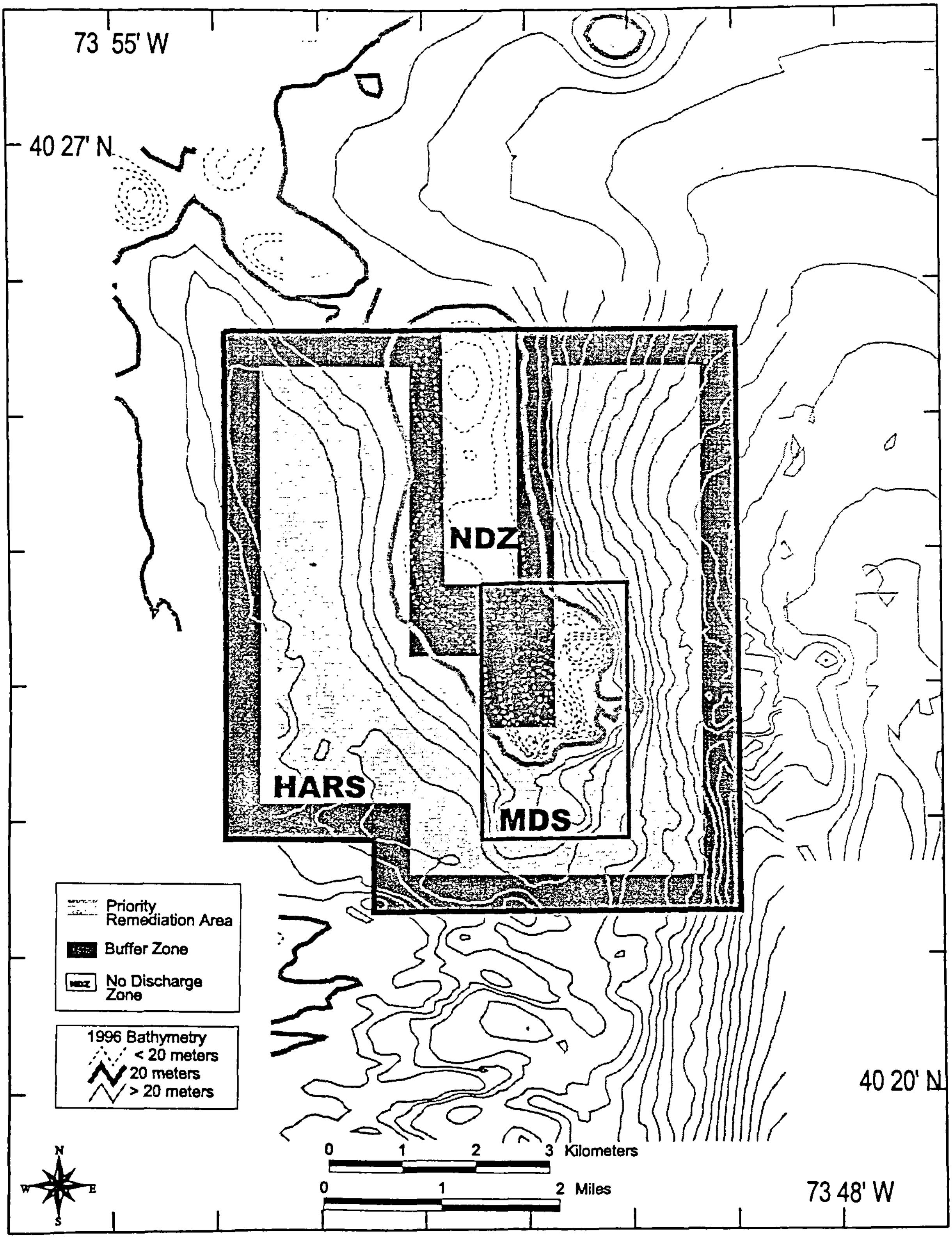

Figure 2. EPA's Proposed Historic Area Remediation Site (HARS) Showing Regional Bathymetry, the Priority Remediation Area (PRA), No Discharge Zone (NDZ), and Buffer Zone (BZ).

2.1.3 Water Quality

Water quality usually is assessed based on the concentrations in the water column of suspended particles (turbidity), dissolved oxygen, nutrients, chlorophyll, and chemical contaminants. These water quality parameters can be affected by direct inputs (e.g., dumping, coastal discharges), indirect inputs (e.g., atmospheric, nonpoint sources), and secondary processes (e.g., remobilization from the seafloor, primary production).

The current water quality of the New York Bight has been significantly influenced by a long history of waste disposal in the Bight. Use of the New York Harbor and Bight as a repository of waste is documented back to the 1800s, and the practice probably goes back much further. EPA Region 2 (1995a) states that raw sewage, garbage, refuse, and street sweepings were routinely dumped into the inner harbor until the early 1900s. As the harbor area developed and the population increased, public complaints about the odor and debris problems, and environmental degradation resulting from these disposal practices, forced the dumping activities out of the inner Harbor area, to the outer harbor, and eventually to the ocean waters of the inner and outer Bight. Other wastes dumped into the Bight included excavation material from bridge, tunnel, and building construction (Williams 1979).

By 1924, there were a number of specific locations in the New York Bight to dispose of wastes and these were formalized in the 1970's under the Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA). In 1987, most ocean disposal of nondredged material in the New York Bight ended. The 12-Mile Site (sewage sludge) was dedesignated in 1990, followed by the Acid Waste Site (industrial acid waste byproduct) in 1991. More recently, the Cellar Dirt Site (construction and excavation debris) and the 106-Mile Site (municipal wastes) were dedesignated. With the cessation of sewage sludge dumping in the New York Bight Apex, pollutant loading decreased and overall water quality improved. Metal loadings decreased up to 35%, biological oxygen demand (BOD) loading decreased 39%, polychlorinated biphenyls (PCB) loading decreased by less than 4%, with ongoing PCB loading suspected from coastal discharges.

Temperature, Salinity, and Density. The hydrographic structure of the New York Bight, including the influence of the Hudson River estuary, has been well documented (e.g., Bowman and Wunderlich 1977). Water temperatures in the New York Bight have a seasonal cycle with little variability. There is seasonal evolution from vertically homogeneous temperature structure in winter to peak stratification in summer. Salinity fluctuates from low values in spring and high, oceanic values in summer. The seasonal pattern of surface water salinity in the Bight is dominated by freshwater inflow from rivers, particularly the Hudson River and waters from Long Island Sound. Peak freshwater inflows to the Bight occur in April; lowest flows usually are recorded during September.

New York Bight water reaches its maximum density during the winter (January, February, March) when temperatures are at their lowest and salinities are high (Bowman and Wunderlich 1977). At this time of year, the lowest temperatures occur near the coast, increasing offshore. In the Bight Apex, sea surface temperatures drop to less than 2° C in the winter, during which time there is little river runoff offshore and strong vertical mixing leading to an almost completely unstratified water column. Bottom temperature tends to be slightly warmer than surface temperature in the winter. While the water column is well-mixed there is deep wave penetration and essentially a one-layer flow. The winter hydrographic features are dominated by a temperature, salinity, and density front that separates continental shelf and slope waters.

Warming begins in the spring (April, May) when river runoff reaches its maximum. Near the coast, the entire water column warms. Offshore in the Apex, the water column begins to stratify in the spring (i.e., bottom temperatures remain cold and surface water temperatures rise.) Surface temperatures reach 7° C to 8° C in April and May, but bottom temperatures rarely exceed 4° C except near the south shore of Long Island. Strong thermal stratification begins to appear in May. The plume of low salinity water from the Hudson River is strongly evident in the Bight Apex through most of the year. The Hudson River plume follows the New Jersey shore south and frequently overruns the Study Area; a band of high-salinity water is often trapped coastward of the Hudson River Plume.

The thermocline intensifies during summer (June, July, August) while bottom temperatures remain unchanged. Close to the coast, where bottom depth is less than the depth of the thermocline, rapid warming occurs. The shelf-break front that dominated the winter hydrographic properties and the associated subsurface, warm intrusion disappears as the upper surface layers continue to warm (Bowman and Wunderlich 1977). The surface temperature gradient and depth of the thermocline reach their maximum in early August and remain so for the month. This two layer structure prevents the wind energy from reaching the bottom, so the bottom current velocities are effectively decoupled from the surface velocities. The salinity distribution during low river discharge in summer is characterized by a weak low-salinity plume around Sandy Hook and patches of surface water of variable salinity spread throughout the inner shelf of the Bight.

During the fall (September, October) and early winter (November, December), the thermocline breaks down due to surface cooling and the increase in wind stress. The vertical overturning deepens the isothermal layer and warms bottom water. Eventually the shelf waters are almost entirely isothermal. The isothermal layer is 20 m deep in the Apex and 40 m deep in the Bight. Destabilization of the water column by surface cooling and wind stress is usually stronger than buoyancy from river runoff and breaks down the vertical salinity gradient and leads to a steady increase in surface salinity. Strong winter vertical mixing dissipates any isolated patches of low-salinity water present during the summer.

Turbidity, Dissolved Oxygen, and Nutrients. The outflow from the Hudson River (i.e., Hudson River plume) strongly influences the water quality in the Study Area and throughout the New York Bight Apex. The concentrations, and spatial temporal distributions, of particles, nutrients, and contaminants in the Study Area respond to this outflow and result in a decreasing offshore gradient for many of the above parameters. In addition, the Hudson River plume exerts significant influence on the salinity and density structure of the water column. These physical gradients influence the spatial and temporal variability in turbidity, dissolved oxygen, nutrient, chlorophyll, and contaminant concentrations in the water column of the Study Area.

Turbidity. Water column turbidity (suspended solids) can be affected by many factors including growth of phytoplankton, river plumes, and natural and anthropogenic events that resuspend sediments. Dragos and Peven (1994) reported low turbidity throughout the water column in June 1994 with a small mid-depth maximum in the central portion of the Study Area. This feature appeared to extend from the north and west into the Study Area, but did not extend to the east side of the Study Area. Turbidity in the water column on the east side of the Study Area did not show any distinguishing vertical features during the survey. Turbidity contours at the 8-m depth clearly show that this mid-depth turbidity maximum extends from coastal New Jersey into the MDS. The data do not reveal elevated turbidity in the vicinity of the MDS that might be attributable to dredge material disposal, but do show that the Hudson River discharge and coastal currents exert a significant influence on the turbidity in the Study Area. Time series tracking of individual dredged material plumes demonstrated that turbidity associated with dumping events in the

MDS decline to background levels within a few hours (Dragos and Lewis 1993; Dragos and Peven 1994). These data indicate that dredged material disposal in the MDS environs has a transient impact on the water clarity.

Resuspension of surficial layers of bed sediments during high energy events can also affect the turbidity in the water column.

Dissolved Oxygen. Prior to transfer of sewage sludge disposal to the 106-Mile Site in 1986, the disposal of the sludge at the 12-Mile Site contributed to unacceptably low dissolved oxygen concentrations in the water and sediments of the New York Bight Apex (HydroQual 1989a). The low oxygen concentrations were part of an area-wide eutrophication characterized by elevated nutrient concentrations and high phytoplankton production in surface waters.

Dissolved oxygen concentrations in the inner Bight increased measurably after sewage sludge disposal was moved from the 12-Mile Site to the 106-Mile Site. During the summer months of 1983 to 1985, oxygen concentrations in bottom waters of the most heavily impacted area within the 12-Mile Site frequently were as low as 0.5 mg/L. In the summers of 1987 through 1989, after cessation of dumping, oxygen concentrations increased to about 4 mg/L, with the lowest concentration of 2.5 mg/L recorded in 1989 (Mountain and Arlen 1995). Similar results were obtained in a study conducted by EPA Region 2 in coastal waters off New Jersey and New York. After 1986, nearly all oxygen measurements (99.3%) in bottom waters were above 2 mg/L, and no values below 2 mg/L were recorded after 1988.

Nutrients. The two inorganic nutrients that have the greatest effect on primary production in the ocean are phosphorous and nitrogen. Other major nutrients, notably silicon, as well as many micronutrients and metals are also necessary for plant growth, and may enhance or retard production based on local conditions. Primary production in most coastal marine ecosystems is limited by concentrations of available phosphorous and nitrogen present in the euphotic zone of the water column and taken up by plants as phosphate and nitrate.

Globally, the major source of phosphorous is land drainage, with the ocean acting as vast reservoir of these nutrients. Nitrogen compounds also enter the sea from land runoff, but a large proportion also enters the marine environment through the atmosphere. Marine algae require sufficient quantities of both phosphorous and nitrogen to grow and reproduce. The vast majority of these algae are microscopic phytoplankton that live in surface waters of coastal areas that are rich in nutrients and receive sufficient light for primary production (i.e., plant growth).

In the waters of the New York Bight and Bight Apex, coastal enrichment from land-based nitrogen sources is of concern. Over-enrichment from land-based nitrogen contributes to the area's phytoplankton communities growth especially during the summer. At excessive levels, this can lead to eutrophication and depletion of oxygen in the water column and other deleterious effects. The great majority of nitrogen entering the Bight originates from sewage discharges that enter the area in the Hudson River plume. Another source of nitrogen to Bight waters is atmospheric deposition. Coastal inputs tend to have a greater relative importance closer to shore in the Bight, whereas atmospheric sources are more important at Bight-wide scales.

The nutrient flux of the Study Area is dominated by the Hudson River plume which is driven by nutrient loading from New York-New Jersey metropolitan area and watersheds (Stoddard *et al.* 1986, HydroQual 1989b). Stoddard *et al.* (1986) summarized data from over 3,000 stations that were sampled between 1973 and 1981 in the greater New York Bight, and showed that nutrient concentrations have a winter maximum (period of lowest productivity) and a summer minimum (when primary production is high). The amplitude of this cycle decreases seaward. Primary production is highest in the spring with a decline in production during the summer and a secondary maximum in the fall. Primary production is highest in the surface euphotic zone of the water column. As phytoplankton die and sink, the resulting organic matter decomposes and consumes bottom-water oxygen.

In the past 10 years, nutrient loading to the Bight has decreased, resulting in a substantial improvement in overall water quality. Eutrophic conditions have declined with the decrease in phytoplankton production in surface waters, and bottom-water oxygen concentrations have increased proportionately. Disposal of dredged material in the Study Area remains, as in the past, a minor source of nutrients to the Bight.

Contaminants. Contaminant concentrations in the water column of the Bight Apex are generally low (Hanson and Quinn 1983) and do not exceed marine water quality criteria. The low total suspended solids concentration (TSS) in the waters of this offshore region causes most contaminants to be present in the dissolved phase (EPA Region 2 1991; 1992). Recent data also show that the concentrations of most metals (and by extension organic contaminants) in the water column decrease with distance offshore from the mouth of the Harbor (HydroQual 1989b). The decreasing offshore gradient (Klinkhammer and Bender 1981; Hanson and Quinn 1983; HydroQual 1989b; EPA Region 2 1991; Battelle 1992a; EPA Region 2 1992) directly reflects dilution of the contaminant concentrations in the Hudson River plume with seawater from the Bight region. Variations in this gradient may occur as the flow of the river changes and in response to other climatological factors that affect the mixing and transport regimes of the inner Bight. The seasonal stratification of the water column also affects the vertical distribution of contaminants. For example, metals concentrations in surface waters are consistently higher than in waters from below the pycnocline. This reflects both the influence of the Hudson River outflow on the surface waters of the Bight and natural geochemical processes that transport metals through the water column. However, repeated sampling of the water column in the vicinity of the MDS shows that metal concentrations in this area are low, with little variability, and typical for natural background concentrations of metals in marine waters.

2.1.4 Oceanographic Processes

Much of the oceanographic conditions at the Study Area are the result of the large freshwater inflow to the Bight Apex.

Hudson River and Long Island Sound waters are the two largest sources of fresh water to the northwest Atlantic Ocean. Together, they significantly affect the salinity distribution and circulation in the New York Bight Apex and the Study Area. Ketchum and Keen (1955), showed that the total annual discharge of the Hudson and other rivers displaces a volume of water equal to 50% of the total volume of the Bight Apex. This is quickly dispersed by active circulation in the Bight (residence time of fresh water in the Bight is 6 to 10 days). The mean monthly inflows from the Hudson River and the Long Island Sound may vary by as much as a factor of 10 from year to year. Correspondingly, salinity distribution in the Bight Apex and the Study Area reflects this variability.

Currents. The general structure of current velocity in the Middle-Atlantic Bight has been extensively described by several investigators [see the review by Beardsley and Boicourt (1981)]. The magnitude of the currents generally increases with distance offshore and decrease with depth. The mean flow measured by long-term current meter moorings on the Atlantic shelf is to the southwest parallel to depth contours through the New York Bight at an average speed of 2 to 4 cm/s. Mean residence time of ocean water in the New York Bight is 9 months.

Like all surface waters, Bight water responds to the frictional drag of the local wind. Wind stress tends to be directed offshore during winter when it is at its maximum. In summer, southwest longshore wind stress predominates. It is well documented (Beardsley and Boicourt 1981) that the mean southwestward circulation is dramatically altered by weather events, particularly cyclonic winter storms. Southwestward flow is greatly enhanced by winter northeasterly storm events on the shelf. Beardsley and Boicourt (1981) showed that strong winter storms could produce along-isobath currents from 20 to 50 cm/s in the mid-shelf region. Mayer *et al.* (1982) found that during periods of sustained wind stress directed from the northeast (January 1976 and November 1976 through January 1977), upwelling occurred in the Bight Apex as the near-bottom water flowed upshelf. This effect was found to be enhanced in the Hudson Shelf Valley. Han and Mayer (1981) found offshore bottom layer flow only in response to northward wind stresses.

Current/wave data collected at three locations in the northeast corner of the MDS during non-storm events indicate that non-storm variations in near-bottom currents may be the result of bottom topography, rather than water depth. During storm events, waves of 12 to 14-s periods, near-bottom current flow was greater at deeper depths (23-m versus 12-m) (SAIC 1993).

Waves. The prevailing direction of waves in the region follows the prevailing wind directions, from the northwest in fall and winter and from the south in spring and summer. The maximum recorded height in the Bight is 7.3 m. The highest waves were recorded during the winter months and in the early spring with waves exceeding 2.0 m about 4 percent of the time and 3.0 m about 1 percent of the time. The most common occurrence of high waves is in March and December with wave height exceeding 2 m more than 5 percent of the time.

2.1.5 Sediment Distribution, Quality, and Transport

The New York Bight is characterized by sediment heterogeneity related in part to a series of ridges (up to 10 m in height) and swales (2-4 km wavelength) on the continental shelf and the major topographic features of the Bight, Hudson Shelf Valley, and Christiaensen Basin. Natural surface sediments of the greater New York are characterized as a "sheet of sand up to 10 m thick with small areas of gravel and muddy sand" (Freeland and Swift 1978). The dominant minerals are quartz and feldspars (Freeland and Swift 1978). Finer grained sediments (muddy sand) are often associated with swales and other topographic low areas (Harris 1976; Krom *et al.* 1985).

Historic dumping of dredged material in the Study Area has altered the surface sediment texture within the Study Area. Recent data indicate that the surface sediments within the MDS are highly heterogeneous, consisting of areas containing mud, sand, and rocks. Areas with more than 50% mud are found along the northern portion of the western boundary of the Study Area. Areas consisting mostly of sand (<1 percent mud) are found in the northwest quadrant of the Study Area. These sandy sediments extend toward the northwest outside the Study Area to the entrance to New York Harbor. This region includes the areas that have received dredged material over the past 100 years and includes the highest topographic features of the area. Sediments along the western boundary of the Study Area and the Hudson Canyon Valley consist of mud. Fine to medium and coarse sands also cover the southern half of the Study Area. The region of the former cellar dirt site is characterized as sandy gravel and artifactual gravel. The Shewsbury Rocks shoal extends seaward from the New Jersey shore to the southwestern portion of the Study Area. Also, the southwestern portion contains sand waves and ripple fields. These features are also found along the eastern and southern slopes of the dredged material mounds in the MDS, east of the MDS in the head of the Hudson Shelf Valley, and along the slopes of the dredged material mound in the northwest quadrant of the Study Area (SAIC 1995). Rocks and rock outcrops can be found at isolated locations throughout the region.

Sediment Quality. The distribution of metals and organic contaminants in sediments of the New York Bight are the result of natural distributions (metals), deposition from land runoff transported by the Hudson River plume, atmospheric sources, and ocean disposal activities over the last 100 years.

Metals. Metals concentrations in the sediments of the New York Bight have been measured during several field sampling programs over the past 25 years. One of the most comprehensive compilations and reviews of metals (Zn, Cr, Cu, Pb, Ni, Fe, Hg, and Cd) data for the New York Bight was published by Krom *et al.* (1985). This study shows that sediments in the Bight consist of two distinct types: (1) sandy sediments low in organic carbon and with relatively low concentrations of leachable metals (metals stripped from the substrate with weak acid solutions) and (2) silt-clay sediments containing high organic carbon and leachable metals concentrations.

The highest metal concentrations were consistently found in the MDS and immediately adjacent areas (i.e., the Study Area), with lower but elevated concentrations at several locations in the Christiaensen Basin and, to a lesser extent, the Hudson Shelf Valley. For example, surficial sediments from the flanks of the historic and current dredge material mound had the highest Hg concentrations (EPA Region 2 1997).

Metals concentrations in the Bight Apex are highly variable. In general, the highest metals concentrations are reported for sediment samples collected in the 1970s (Krom *et al.* 1985). Samples collected in the Bight area in the 1980s (NOAA 1982; JBR 1984; Lewis *et al.* 1989) have a relatively wide range in metals concentrations. The highest metal concentrations in sediments collected in early 1990 surveys (Charles and Muramoto 1991; McFarland *et al.* 1994; EPA Region 2 1997) are consistently lower than those in sediments collected in the 1970s and 1980s.

A consistent decrease in concentrations of copper and other metals in Bight Apex surface sediments over the past few years suggest that surface sediment contamination in the Study Area has probably decreased relative to the 1970s.

Organic Contaminants. Compared to the information on the trace metals in the New York Bight, relatively few recent organic contaminant data are available. Though limited, the available data demonstrate that background organic compound concentrations in New York Bight sediments are generally low (Boehm 1983) and are strongly associated with the amount of fine grained sediment and organic carbon in a given sample.

Historical and recent contaminant data of surface sediments in the Study Area are characterized by a wide range in concentrations. As with metals, the highest organic-compound concentrations are primarily associated with the fine-grained, organic-rich sediment located in the deeper, hydrodynamically quiet regions of the Study Area. Contaminants in sandy sediments from the Study Area are in the range found throughout the greater New York Bight. Fine-grained sediments in the Study Area tend to have concentrations that are somewhat higher than in the Bight. Generally, organic contaminant concentrations appear to have decreased in the Bight since the 1980s based on a comparison of data collected by NMFS in 1980 and EPA in 1994 [see Chapter 3 of the SEIS (EPA Region 2 1997) for further details].

Sediment Resuspension and Transport. The resuspension and transport of bottom sediments throughout the New York Bight is controlled primarily by storm events when wave generated near-bottom oscillatory currents, combined with the mean currents, produce conditions under which bedload and suspended-load transport can occur. Investigators have found that very few events account for the annual resuspension and transport of bottom sediments in the vicinity of the Study Area (Vincent *et al.* 1981; Manning *et al.* 1994). In shallow areas, these storm driven events remove and reinject deposited sediments into the water column. Most suspended sediment is transported in a turbid, near-bottom layer which is typically several meters thick.

Vincent *et al.* (1981) estimated the potential sediment transport rate from current meter records in the vicinity of the Study Area. The role of oscillatory currents in resuspending sediment was considered but not explicitly included in the sediment transport calculation. The transport potential for the overall movement of fine bottom sediments in the area of the Study Area shows two distinct transport patterns: (1) net northward transport in the Hudson Shelf Valley and (2) net southward transport everywhere else. This effect, combined with the depth of the Hudson Shelf Valley and Christiaensen Basin results in the Shelf Valley acting as a sink for the general net southwestward transport of sediment along the shelf in the area of the Study Area. Vincent *et al.* (1981) found that up-valley transport events were associated with northeastward currents on the shelf, but also occurred during quiescent periods.

2.2 Biological Environment

A major factor affecting the seasonal distribution of endangered or threatened whales and turtles in the New York Bight is food. Changes in the distribution of prey species result in changes in the distribution of whales and turtles. Phytoplankton are the base of the food chain for a wide variety of marine organisms. Zooplankton (which feed on phytoplankton and other zooplankton) serve as minor prey for humpback whales, but are the major prey of planktivorous fish, which are fed on by humpback and fin whales. Benthic macroinvertebrates are fed on by loggerhead and Kemp's ridley sea turtles.

2.2.1 Plankton

Malone (1977) provides a comprehensive description of phytoplankton and zooplankton in the New York Bight and Bight Apex, based on studies conducted in the late 1960s to early 1970s. The description is summarized in the following text.

Phytoplankton. Thirty-six phytoplankton species are abundant in the New York Bight Apex. Total phytoplankton densities in the apex are highest in July and lowest in November. Diatoms dominate the abundance in cold weather months, chlorophytes in the warm weather months. The total phytoplankton density in July is dominated by the chlorophyte, *Nannochloris atomus*, which is most abundant near the mouth of the Hudson River and the southern shore of western Long Island.

Zooplankton. Very few comprehensive studies have been conducted on zooplankton in the New York Bight. Zooplankton populations in the Bight are dominated by copepods. Four copepod genera (*Oithona, Paracalanus, Pseudocalanus,* and *Centropages*) comprise the majority of the zooplankton populations in the Bight Apex. *Oithona* and *Pseudocalanus* are abundant year round, whereas, *Centropages* are seasonally abundant. Other species of zooplankton that are abundant seasonally or at low densities throughout the year include, chaetognaths, bivalve larvae, tunicates, and siphonophores. Chaetognaths, which are present throughout the year, are most abundant in near-bottom water in May and July. Bivalve larvae, another component of the zooplankton in the inner Bight, peak in January through March and

August through November. Tunicates are most abundant in the fall. Siphonophores are abundant during all seasons, except for winter. In general, peaks in abundance of zooplankton in the inner Bight occur one to two months after peaks in the Raritan River estuary.

2.2.2 Invertebrates

Loggerhead and Kemp's ridley turtles feed on benthic crustaceans and molluscs. Key crustacean prey include spider crabs (*Libinia emarginata*), northern lady crabs (*Ovalipes oscellatus*), blue crabs (*Callinectes sapidus*) and rock crabs (*Cancer irroratus*). Spider crabs are common throughout the Study Area, especially in the summer, peaking in August. Northern lady crabs are most abundant in inshore areas (their distribution is negatively correlated with depth in the summer and fall) and are inactive (i.e., are not caught in trawls) in the winter (Stehlik *et al.* 1991). Distribution and abundance of spider crabs is not as well documented as the commercially important species of blue crab and rock crab.

Millikin and Williams (1984) summarized the migrations of blue crabs within bays. Adults move to lower salinity water to mate. After mating, *C. sapidus* migrate to higher salinity waters that are suitable for larval development. Males remain in lower salinity water, whereas, females are more mobile. Blue crabs are rarely collected offshore (NOAA, pers. comm. 1996a) and it is unclear if they migrate from coastal bays and inlets to offshore waters. *Cancer irroratus* is primarily a marine species with a continuous distribution from southern New England to the Chesapeake Bight (Musick and McEachren 1972; Williams 1984). Distributions of *Cancer irroratus* apparently are triggered by seasonal cooling and warming. In the New York Bight, *C. irroratus* move inshore in the fall and remain until the spring when they migrate offshore (Stehlik *et al.* 1991). Migrations occur across the continental shelf. Sampling by the State of New Jersey Department of Environmental Protection (NJDEP) indicates that *Cancer irroratus* are collected near the Study Area in the spring before they migrate offshore. Stehlik *et al.* (1991) reported that northern lady crabs are distributed in the inner middle-Atlantic shelf (south of Cape Cod to Cape Hatteras) and Georges Bank, mostly at depths of less than 27 m. In the inner Bight, abundance in the summer is notable, but peak abundance occurs in fall. The abundance of the northern lady crab in the Middle Atlantic region in summer and fall is positively correlated with water temperature.

Several invertebrates, in addition to the zooplankton discussed in the preceding subsection, serve as prey for forage fish that are consumed by fin and humpback whales. Cephalopods, in particular squid, are a prey of mackerel (Bigelow and Schroeder 1953); mackerel are eaten by humpback and fin whales. Squid are the most abundant cephalopods in the New York Bight. Squid are in the Bight from June through October (NJDEP, pers. comm. 1996). Other invertebrate prey of mackerel include amphipods and mysids. These are epibenthic invertebrates that are found in the water column above the Study Area (Battelle 1992b).

2.2.3 Fish

Fish species in the New York Bight Apex are mostly migratory, although there are some species referred to as "shore fishes" (NOAA 1988). The migratory fish move through the Bight Apex as they travel inshore and offshore, and north and south in response to changes in water temperature.

The migration patterns of fish prey preferred by humpback and fin whales influence the distribution of these two endangered whales. Herring, mackerel, capelin, and sand lance are small schooling fish that are the primary prey of humpback and fin whales. All of these species, except for capelin which is a boreal-arctic species, are found within the New York Bight.

Herring (*Clupea harengus*), a boreal species, is distributed from Labrador to Cape Hatteras and moves south through the Study Area in the winter, after spawning in the Gulf of Maine and Georges Bank. In late February and March, herring move offshore, out of the inner Bight, and migrate north.

Mackerel, *Scomber scombrus,* has the same geographic distribution as herring, although, the migration patterns of herring and mackerel are different. Migration patterns of mackerel are described in Overholtz *et al.* (1991). Mackerel move south (from summer grounds) through the Study Area in the fall prior to moving offshore to winter. The fall migration through the New York Bight and the winter distribution are strictly dependent on water temperature. In "warm" winters, adults may remain in the Bight and not move offshore. Spawning takes place in the spring offshore from the New York Bight. After spawning, adults move north to summer feeding grounds in the Gulf of Maine and Georges Bank.

Sand lance, *Ammodytes* spp., are habitat-dependent and are associated with specific topography and sandy sediments (NOAA, pers. comm. 1995b). Sand lance are found in the New York Bight (NJDEP, pers. comm. 1996), with high concentrations off of eastern Long Island and Block Island (NOAA, pers. comm. 1995b).

Both herring and mackerel are non-selective planktivores, feeding on copepods, pteropods, and cirrepods. Sand lance also feed on plankton, but tend to select larger individual prey items (Grosslein and Azarovitz 1982).

The NMFS has reported on the status of stocks for herring and mackerel through 1994 (NOAA 1995a). Because sand lance are prey of mackerel and herring, high abundances of sand lance often occur when abundances of mackerel and herring are low. Currently, mackerel and herring abundances are high (Figure 3); sand lance abundances are recovering from recent lows.

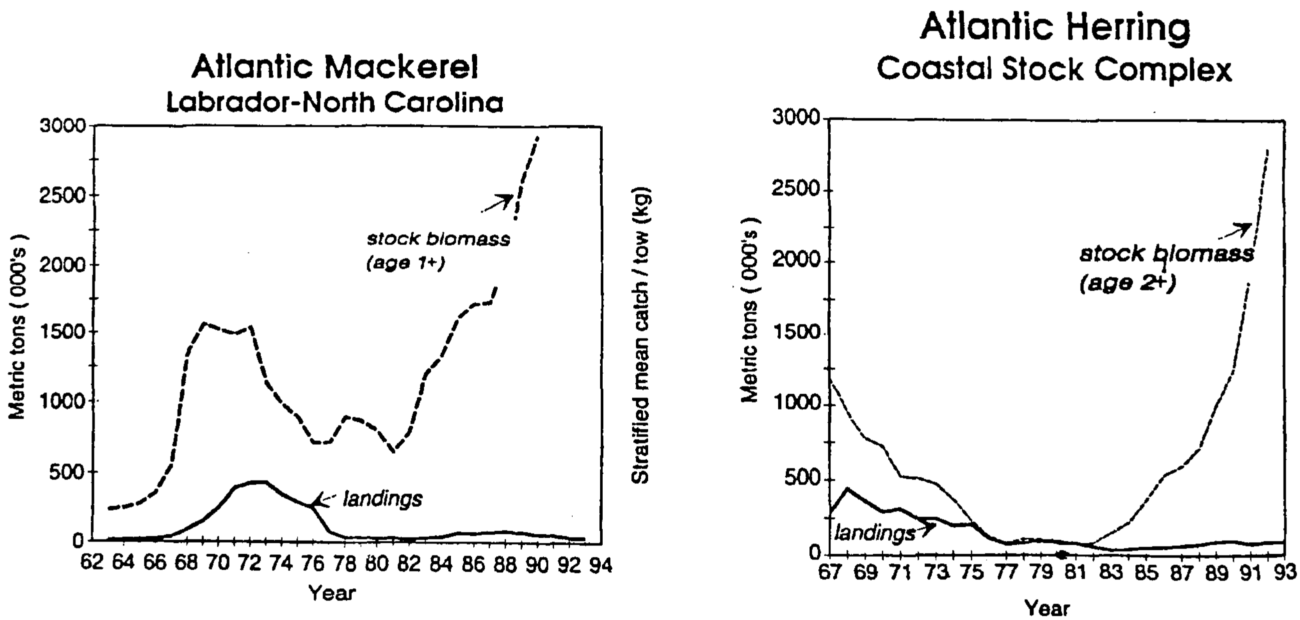

Figure 3. Abundances of Mackerel and Herring in the Northwest Atlantic (NOAA 1995a).

2.2.4 Birds

Endangered or threatened marine birds within the vicinity of the proposed HARS include three migratory species: bald eagle, piping plover, and Eastern peregrine falcon. EPA has conducted an informal consultation with the U.S. Fish and Wildlife Service (USFWS 1995a) on endangered and threatened birds in the Study Area.

*Bald Eagle (***Haliaeetus leucocephalus***).* The bald eagle was designated as a federally endangered species in 1967. Since the 1972 implementation of restrictions on the use of DDT, the number of bald eagles has increased. In fact, the bald eagle has been downlisted from endangered to threatened in the lower 48 states (50 CFR Part 17). From 1988 to 1990 the number of bald eagles observed in New Jersey along the Delaware Bay coast has increased dramatically. Bald eagles are opportunistic feeders that forage in a variety of habitats, including bay shorelines, along rivers and lakes, perched in trees, or in bare sand. They prefer live and dead fish (e.g., menhaden), when abundant (USFWS 1990).

*Piping Plover (***Charadrius melodus***).* Piping plovers were listed as threatened in 1986. The piping plover, a North American shore bird (MMS 1992, USFWS 1995b), has a New York/New Jersey subpopulation (USFWS 1995b). Plover nesting areas include coastal beaches and sandflats. They migrate along the coast, although migration patterns are not well documented, and feed on marine worms found in intertidal areas (USFWS 1995b).

During consultation with the EPA, the USFWS initially raised some concerns about potential impacts to the piping plover (USFWS 1995a). However, the concerns were resolved (USFWS 1995c).

*Eastern Peregrine Falcon (***Falco peregrinus***).* The extensive use of oganochlorine pesticides in the early 1960s was the primary cause of the decline in the number of Eastern peregrine falcon, as it was for the bald eagle described previously. The peregrine falcon was listed in 1970 under the Endangered Species Conservation Act of 1969, and in 1984 all peregrine falcons in the lower 48 states were listed as endangered (USFWS 1991). Currently, the primary threat to these birds is human disturbance of nesting birds. A nesting survey identified fourteen pairs of peregrine falcons in New Jersey (USFWS 1995d). Migrating peregrine falcons may also be impacted. This migratory, bird of prey "move[s] east or west, from the mountains to the coast and back, rather than north or south", but has been observed offshore (USFWS 1991; MMS 1992). They feed almost exclusively on birds (e.g., bluejays, pigeons) while in flight.

2.2.5 Other

*Northeastern Tiger Beetle (***Cicindela dorsalis dorsalis***).* Tiger beetles are found in many nearshore habitats: open sand flats, dunes, water edges, beaches, woodland paths, and sparse grassy areas (USFWS 1994), where they feed on small amphipods, flies, and other beach arthropods. The beetle is one of the indicators of a healthy beach community. Historically, the northeastern tiger beetle was found along the undeveloped coastal beaches from Sandy Hook to Holgate, New Jersey (USFWS 1994). Recent coastal development activities, beach stabilization, and high recreational use have destroyed and disturbed the habitat of the tiger beetle (Hill and Knisley 1994), and resulted in its being listed as threatened in 1990. The USFWS had initially raised concerns about the Proposed Action's potential impacts to the tiger beetle; however, concerns regarding potential impacts to the tiger beetle were resolved (USFWS 1995c).

3.0 NATURAL HISTORY OF ENDANGERED SPECIES

The following chapter summarizes the natural history of the four endangered and threatened species evaluated in this BA.

3.1 The Humpback Whale (*Megaptera novaeangliae)*

3.1.1 Population Status and Trends

Humpback whales (*Megaptera novaeangliae*) occur in all the oceans of the world, except possibly the Arctic (NMFS 1991a). The unique feature of humpback whales that distinguishes them from all other baleen whales is their extremely long flippers that may be 5-m long or about ⅓ of total body length. Humpback whales are about 4-m long at birth and reach a maximum size of about 18 m and a weight of about 48 metric tons (Winn and Reichley 1985). Females are slightly larger than males.

Humpback whales were an important commercial species throughout most of their range, including Long Island and New England waters, until early in the twentieth century (Allen 1916). Some taking of humpback whales occurred in northwest Atlantic waters until the mid-1950s. The International Convention for the Regulation of Whaling, Washington 1946, afforded the North Atlantic population of humpback whales full protection in 1955 (Best 1993). Humpback whales were afforded endangered species status in the United States in 1970 (USFWS 1986), and retain that status today. Although severely depleted by whaling, the species has shown good recovery over most of its range. The best estimate of the annual rate of increase of the humpback whale population in the western North Atlantic Ocean since the cessation of exploitation is 9 percent per year (Katona and Beard 1990).

Prior to exploitation, the worldwide population was thought to number more than 125,000 individuals (Braham 1984; NMFS 1991a). Best (1993) reviewed recent sightings data for 10 of the 11 putative stocks of humpback whales in the world's oceans and concluded that the oceans of the northern hemisphere and Australia support more than 17,500 humpback whales; data for Southern Ocean waters south of 30° S latitude are less certain. The three Antarctic humpback stocks may contain as many as 20,000 individuals, bringing the current world total to more than 37,000 individuals, representing approximately 30 percent of the preexploitation population size.

In 1932, the western North Atlantic population was estimated to contain as few as 700 animals (Breiwick *et al.* 1983), but this may have been an underestimate (Reeves and Mitchell 1986). Katona *et al.* (1994) estimated that the average total humpback whale population in the entire western North Atlantic Ocean between 1979 and 1990 is 5,543 (CV = 0.16) individuals. This compares well with the estimate of Braham (1984) of 5,275 to 6,289 individuals. The western North Atlantic stock of humpback whales is considered to have nearly or completely recovered (Braham 1984).

The humpback whale population can be divided into 11 to 13 breeding stocks each of which winters and reproduces in a different clearly-defined tropical and sub-tropical area worldwide (NMFS 1991a; Best 1993). The western North Atlantic breeding stock winters in the Lesser and Greater Antilles Islands of the eastern Caribbean Sea. During the spring and summer, whales from this stock split into five feeding aggregations that migrate to and feed along the coasts of Iceland, southwestern Greenland, Newfoundland and Labrador, the Gulf of St. Lawrence, and the Gulf of Maine (Payne *et al.* 1986; Katona and Beard 1990; NMFS 1991a).

Humpbacks belonging to the Gulf of Maine feeding aggregation were estimated by mark-recapture methods to number approximately 240 individuals in 1986 (Katona and Beard 1990). This may be an underestimate; more than 600 humpback whales have been photo-documented in the Gulf of Maine since 1979, and more than 400 humpbacks were photo-documented in 1988 alone (NMFS 1991a). Volgenau and Kraus (1990) produced a mean population estimate for the Gulf of Maine of 447 individuals, and a range from 340 to 555 whales. Some whales from the St. Lawrence River estuary and Canadian Maritimes (Bay of Fundy and Scotian Shelf) feeding aggregations move through New England waters during their biannual migrations between summer and winter habitats.

Humpback whales that are observed with increasing frequency in the Middle-Atlantic Bight each winter may be from the Gulf of Maine, Newfoundland, and St. Lawrence River estuary feeding aggregations. Individuals identified in one feeding aggregation occasionally are observed in another aggregation (Katona and Beard 1990). Whales from the Gulf of Maine aggregation have been observed in the Gulf of St. Lawrence and Newfoundland aggregations. Humpbacks from these three feeding aggregations seem to congregate preferentially in winter breeding and calving areas off the Dominican Republic and eastern Puerto Rico (Katona and Beard 1990) and may follow similar southward migration routes from summer feeding areas to winter breeding areas. Between 50 and 100 humpback whales are observed each year in the New York Bight (Sadove and Cardinale 1993). Most of these whales are non-reproducing juveniles.

Female humpback whales reach sexual maturity after 4 to 6 years and thereafter give birth approximately every 2 or 3 years, although intervals of one to five years between successive calvings have been observed (Clapham and Mayo 1987; NMFS 1991a; Clapham 1992). Most births take place in the winter in the West Indies.

Mothers usually nurse their calves for a year or less (Clapham 1992; Baraff and Weinrich 1993). Weaning may begin when the calves are five to six months old and still in the northern feeding grounds (Clapham and Mayo 1987; Baraff and Weinrich 1993). After weaning their calves, the adult females are ready to mate again. The gestation period is 10 to 12 months (NMFS 1991a) and some females have been sighted with newborn calves 2 or 3 years in a row (Weinrich *et al.* 1993), suggesting that mating may occur while the female is still nursing. The life span of humpback whales is at least 30 years (Chittleborough 1959).

3.1.2 Seasonal Distribution in Middle-Atlantic Bight Waters

Juvenile humpback whales have been observed feeding within 4 km of shore off the coast of Virginia during January through March (Swingle *et al.* 1993). It is probable that the distribution of these whales extends northward into the New York Bight. All the humpbacks sighted off Virginia Beach, VA, are less than 11 m long, indicating that they are sexually immature juveniles. Anecdotal observations by commercial and recreational fishermen in the area (Swingle *et al.* 1993) and stranding records for humpbacks along the U.S. Atlantic coast between 1985 to 1992 (Wiley *et al.* 1995) indicate that these aggregations of juvenile humpback whales in nearshore waters of the middle Atlantic are a recent phenomenon. The recent reappearance of juvenile humpback whales in nearshore waters of the Middle-Atlantic Bight may be due to the expanding range of one or more feeding aggregations of humpbacks or to changes in prey distribution (Wiley *et al.* 1995).

Farther north, humpback whales regularly visit the New York Bight, where they are present in greatest abundance between June and September (Payne and Heinemann 1990; Sadove and Cardinale 1993). All age classes, including mother/calf pairs, are present during the summer. Smaller numbers, nearly exclusively solitary juveniles, frequently are observed in the bight during December and January.

Humpback whales are observed most frequently and for the longest periods of time in the New York Bight in Long Island Sound, Block Island Sound, Cox's Ledge, east and south of Montauk Point and in Gardiner's Bay (Figure 4). They sometimes are sighted off Fire Island in September and October. They also frequently visit coastal bays and inlets along the south shore of Long Island and the mouth of the Hudson/Raritan estuary. There have been increased sitings in recent years of great whales, including humpbacks, near the mouth of the Hudson River and in the lower reaches of the Hudson River estuary (Sadove and Cardinale 1993; Kiviat and Hartwig 1994). The seasonal distribution of humpback whales in New England and New York waters suggests that most of the humpbacks sighted in the New York Bight are part of the Gulf of Maine feeding aggregation (Wiley *et al.* 1995).

Humpback whales have been observed migrating northward offshore the Middle-Atlantic states during mid-to-late spring (Lee and Socci 1989). Some of these whales may stop off in the New York Bight to evaluate the availability of suitable foods. Humpbacks remain in the Gulf of Maine for nearly eight months each year, feeding on the abundant populations of schooling fish and crustaceans (Kenney *et al.* 1981; Kenney and Winn 1986). Individuals or small groups of whales from this feeding aggregation may periodically move southward into the New York Bight and coastal waters of the middle Atlantic during the feeding season in search of food. Those humpbacks that have been identified in the middle Atlantic to date are from the Gulf of Maine feeding aggregation (Wiley *et al.* 1995).

Apparently, the juvenile humpbacks that congregate along the middle Atlantic coast during the winter do not make the migration to the tropical breeding grounds, but instead remain in the north to feed over the winter (Swingle *et al.* 1993). The main activity of adult and juvenile humpback whales in the New York Bight and middle Atlantic year-round is feeding (Swingle *et al.* 1993; Sadove and Cardinale 1993). Increases since about 1975 in the abundance of humpback whales feeding in the vicinity of Stellwagen Bank in the Gulf of Maine have been attributed to a population explosion of sand lance *Ammodytes americanus*, a favorite food of humpback whales (Payne *et al.* 1986, 1990). Since 1975, there has also been a dramatic increase in the abundance of sand lance in the Middle-Atlantic Bight (Meyer *et al.* 1979). Recently, sand lance abundances have begun to recover (NOAA, pers. comm. 1996b) as have the abundances of mackerel and herring. Perhaps this change in the relative abundances of different preferred foods has encouraged humpback whales of all ages to visit the bight during summer months and has enabled juveniles to remain over the winter.

3.1.3 Food and Feeding Behaviors

Humpback whales feed opportunistically on a wide variety of species of pelagic crustaceans and small fish. Sand lance *(Ammodytes americanus* and *A. dubius)* currently is the most important food of humpback whales in the western Gulf of Maine (Hain *et al.* 1982; Payne *et al.* 1986, 1990). Capelin (*Mallotus villosus*) and euphausiids (*Meganyctophanes norvegica*) are preferred foods of humpback whales in more northern U.S. and Canadian waters (Whitehead and Glass 1985). Humpbacks observed south of Cape Cod and off Rhode Island in the spring are feeding on dense patches of euphausiids (Kenney and Winn 1986). During their seasonal northern residency in the area, they may also feed on several commercially important fish, such as herring (*Clupea harengus*), mackerel (*Scomber scombrus*), menhaden (*Brevoortia tyrannus*), pollock (*Pollachius virens*), small haddock (*Melanogrammus aeglfinus*), and squid (*Illex illecebrosus*) (Overholtz and Nicolas 1979; Whitehead and Glass 1985; Whitehead 1987; Piatt *et al.* 1989; NMFS 1991a).

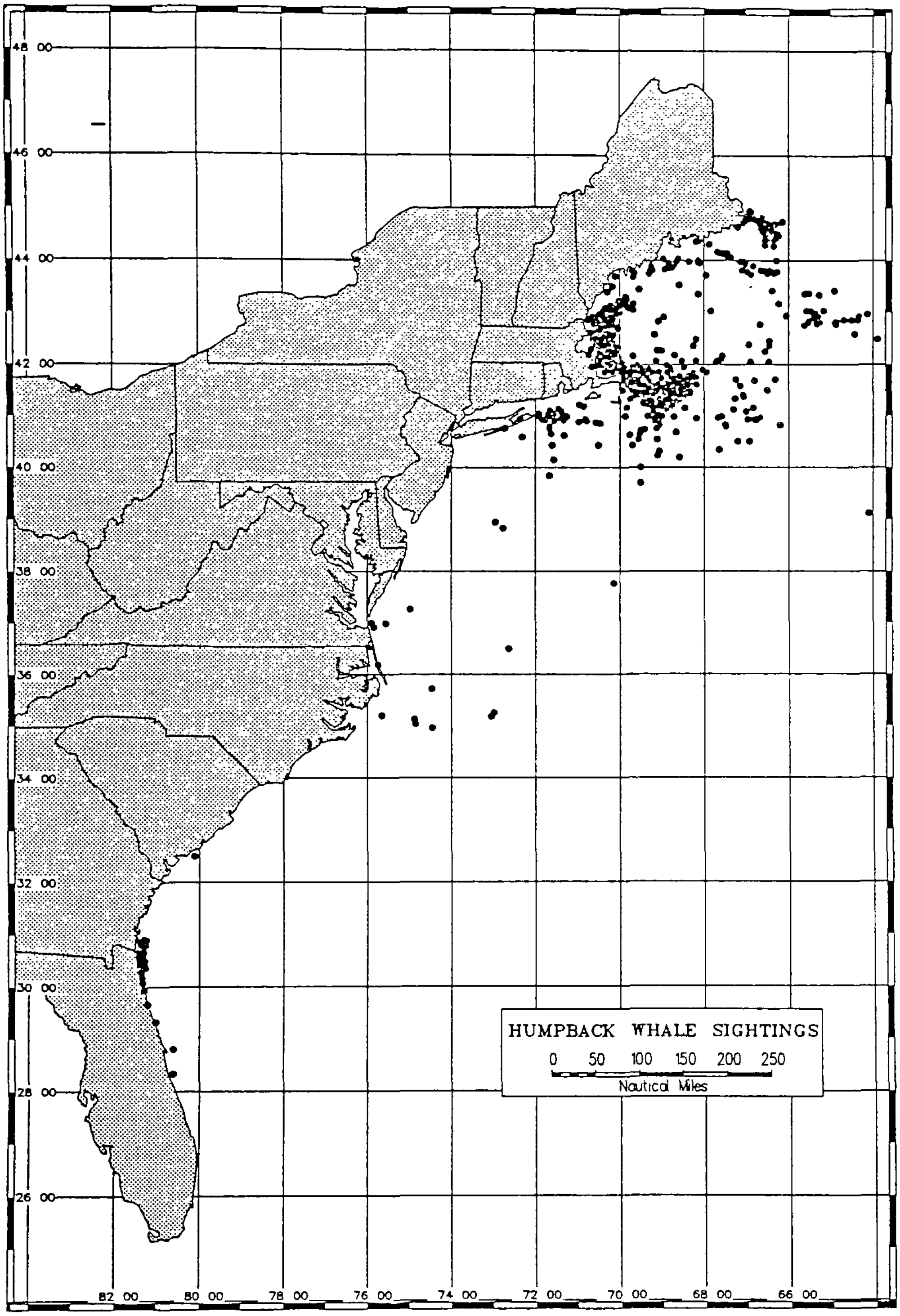

Figure 4. Distribution of Humpback Whales 1960 - 1992 in the Northwest Atlantic (Source: NMFS unpublished data).

Humpback whales spend most of their time in northern waters, such as the New York Bight and the Gulf of Maine, concentrated where their preferred foods are most abundant. Humpbacks are found most often in areas of upwelling, along the edges of banks, and over rapidly changing bathymetry along the continental shelf, and along frontal zones between well-mixed and stratified water masses. An abrupt change in water depth on the shelf may cause upwelling or other oceanographic conditions that favor dense aggregations of near-surface zooplankton and shoaling, plankton-feeding fish upon which the whales feed. Fine-scale movements of humpback whales along these features probably are controlled by the distribution of their prey (Brodie *et al.* 1978; Gaskin 1982; Kenney and Winn 1986; Dolphin 1987a,b; Mayo *et al.* 1988; Payne *et al.* 1990).

Apparent declines in the abundance of humpback whales feeding on Georges Bank may be related in part to declines in the local abundance of some of these commercial fisheries species due to overfishing. There were dramatic increases in the abundance of sand lance (a favorite food of humpback whales) in both the western Gulf of Maine (especially on Stellwagen Bank) and on Georges Bank in the late 1970s and early 1980s (Meyer *et al.* 1979; Payne *et al.* 1986, 1990). The increase in the abundance of sand lance coincided with a large decline in the abundance of several commercial fish species, particularly herring and mackerel (Clark and Brown 1977; Anthony and Waring 1980; Grosslein *et al.* 1980), leading Sherman *et al.* (1981) to speculate that sand lance had replaced these species in the zooplanktivore niche throughout the middle Atlantic, Gulf of Maine, and Georges Bank. The large increase in most years since the mid 1970s in the abundance of humpback whales feeding in the western Gulf of Maine, particularly on Stellwagen Bank, is directly related to the increase in abundance of sand lance populations there (Payne *et al.* 1986, 1990); however, humpbacks on Georges Bank apparently do not feed preferentially on sand lance and their reduced abundance there may be due to declines in the abundance of some other forage species (Payne *et al.* 1986) or to climatic changes that may also have affected the abundance of zooplankton on the bank (Kane 1993; Kann and Wishner 1995). In the middle to late 1980s, a gradual decline began in sand lance abundance, accompanied by an increase in herring abundance in the Gulf of Maine (Fogarty *et al.* 1991). This change in fish populations has been accompanied by a decrease in the numbers of humpback whales in the vicinity of Stellwagen Bank and an increase in their numbers farther north in waters of Cultivator Shoals, the northwest peak of Georges Bank, and Jeffreys Ledge, where herring are more abundant (Blaylock *et al.* 1995).

The New York Bight Apex does contain some of the bathymetric and oceanographic features that favor dense aggregations of humpback foods, but they are not developed to the extent that they are farther north around Stellwagen Bank, Jeffreys Ledge, Browns and Bacaro Banks, and the Great South Channel (Kenny and Winn 1986). Therefore, the preferred foods of humpback whales and the whales themselves do not occur in the New York Bight in the same high numbers that they occur in high-use areas farther north.

Between 1980 and 1986, abundances of sand lance and mackerel in the New York Bight Apex were highest in the spring (Smith *et al.* 1988). Sand lance occur inshore to mid-shelf, whereas mackerel are more abundant along the mid-shelf and along the shelf edge. Herring migrate into coastal and offshore waters off southern New England and the Middle-Atlantic Bight during the winter (Grosslein and Azarovitz 1982) and spring (NOAA 1996c), respectively. Populations of sand lance have declined, but are recovering, and populations of herring and mackerel are increasing in the New York Bight region, as they are in the Gulf of Maine (Fogarty *et al.* 1991). Sand lance abundance in the New York Bight affects the abundance of humpback and fin whales there (McKenzie and Nicolas 1988). As the sizes of stocks of different forage fish fluctuate in coastal waters of the middle and north Atlantic, it is probable that the abundance and seasonal residency of humpback whales in different regions of the New York Bight may change.

Humpback whales have the most diverse repertory of feeding behaviors among the great whales. They may feed singly or in closely coordinated groups. Groups of up to 22 may lunge in unison at surface schools of fish (Hain *et al.* 1982; Würsig 1990). In lunge-feeding, a whale rushes at a school of fish or euphausiids near the water surface at an angle of 20° to 40°, and occasionally up to 90°, opens its mouth just before reaching the school, engulfing the school, and breaking the water surface with mouth agape (Watkins and Schevill 1979). As much as ⅓ of the body may clear the water surface during a lunge. The whale then closes its mouth and forces the water out through the baleen plates by contracting the mouth cavity, trapping the prey inside. Between lunges, the whale often rests for several seconds to a few minutes, often at a depth of 4 to 6 m, presumably swallowing its prey, before lunging again. Humpbacks also lunge-feed on schools of fish and crustaceans located at mid depths or near the bottom. When feeding at depth, the whale rarely breaks the water surface at the end of the lunge.

Humpbacks may use a variety of herding strategies to force potential prey into a tight aggregation easy to consume in a single gulp. They may use their flukes and fins to slap the water, possibly confusing or stunning prey. Humpback whales, singly or in groups, also produce bubble clouds (single, 4-m to 7-m diameter dome-shaped clouds composed of small uniformly sized bubbles) and bubble columns (smaller, 1-m to 1.5-m structures composed of randomly sized bubbles) that encircle or confuse prey long enough for the whales to consume them (Hain *et al.* 1982). Several neighboring whales may bubble net at the same time, increasing the effectiveness of the feeding stratagem.

Approximately 65 percent of the humpback whales feeding in Massachusetts Bay, particularly on Stellwagen Bank, have scuff marks on their lower jaws, suggesting that they have been feeding on or in the bottom (Hain 1991a). This may be a specialized behavior of humpbacks feeding on sand lance. When not schooling, sand lance spend much time buried in sandy sediments (Meyer *et al.* 1979).

Humpback whales are unlikely to feed on the bottom within the Mud Dump Site in the New York Bight Apex. The coarse sandy sediments that sand lance favor are not abundant in the HARS and sand lance are not known to concentrate there in large enough numbers to attract feeding humpback whales. Stellwagen Bank is the only location where humpbacks have been observed feeding on the bottom. It appears that the humpbacks that visit the New York Bight to feed are feeding primarily or exclusively on pelagic fish and invertebrates, such as herring, mackerel, and euphausiids.

3.1.4 Known Disturbance and Mortality Factors

Very little is known about the natural mortality of humpback whales. Parasites, ice entrapment, predation by killer whales, and fluctuating prey populations due to events such as El Niño may contribute to natural humpback mortality rates (NMFS 1991a). Young or sick humpbacks seem to be particularly vulnerable to attacks by killer whales (*Orcinus orca*) and occasionally by larger predatory sharks (NMFS 1991a). In the western North Atlantic, 14% (464/3365) of the appropriately photographed humpback whales bear scars, primarily on their flukes, from killer whale attacks (Katona *et al.* 1988; NMFS 1991a). Although humpback whales and killer whales have been observed feeding near one another without aggressive interactions (Dolphin 1987c), killer whales have been observed attacking and killing other species of baleen whales (Hancock 1965; Baldridge 1972; Silber *et al.* 1990).

The most common anthropogenic source of mortality for humpback whales in the western North Atlantic is entanglement in commercial fishing gear, particularly off Newfoundland (O'Hara *et al.* 1986; Lien *et al.* 1989a,b; Hofman 1990; Volgenau and Kraus 1990; NMFS 1991b). Nearly 600 humpback whale entanglements, leading to 93 verified deaths of whales (15%), were recorded in Newfoundland waters between 1979 and 1989 (Lien *et al.* 1989b). Between 1975 and 1990, 47 humpback whales were reported entangled in various types of fishing gear in U.S. waters. Five of these entanglements were fatal (10.6%). The NMFS (1991a) reported 18 entanglements on the outer continental shelf of the northeastern U.S. Of these entanglements, 9 of the whales were freed by volunteers, 6 whales died, and the fate of the other 3 is unknown. Entanglement mortalities tended to increase as the size of the whale decreased. Overall, 12.4% of the photographed flukes and 6.3% of the tail stocks of the western North Atlantic population are scarred due to encounters with fishing gear (Hofman 1990; Volgenau and Kraus 1990). Twenty-five percent (5/20) of juvenile humpback whales stranded along the central and southeast Atlantic coastlines had injuries indicative of entanglement in fishing gear (Wiley *et al.* 1995). Volgenau and Kraus (1990) estimated that the annual loss of humpback whales to entanglement mortality is about 0.3% for the Newfoundland population and 0.2% for the Gulf of Maine population.

Commercial fisheries may compete directly with the whales for a particular preferred species of fish, as has happened with the capelin fishery off Newfoundland (Lien *et al.* 1990), or the whales may become entangled in fishing gear, as happens frequently in both Newfoundland and the Gulf of Maine (Hofman 1990; Volgenau and Kraus 1990). Humpback whales in the Gulf of Maine become entangled most frequently in gill nets, followed by weirs and seines (Volgenau and Kraus 1990). In inshore waters of Newfoundland, entanglement occurs most frequently in cod traps, followed by groundfish gill nets and salmon gill nets (Hofman 1990). A total of 18 humpback whales have been reported entangled in lobster gear in coastal waters between New Jersey and New England between 1976 and 1993 (NMFS 1994). Two humpback whales were entangled in New Jersey, one in New York, and 11 in coastal waters of Massachusetts. Only 1 of the whales died as a probable result of the entanglement (NMFS 1994). Entanglement will not be a threat for right whales because they should be able to detect and avoid the taut-line mooring configurations.

In general, collisions with ships and large motor boats are a constant threat to humpback whales, although less than for right whales. There are many fewer reports of ship collisions involving humpback than right whales (NMFS 1991a). This may mean that humpback whales are better able to avoid oncoming vessels or have a behavior repertoire that does not put them in harm's way as frequently as right whales.

Humpback whales are relatively tolerant of boats (Pett and McKay 1990) and are seen frequently in the Great South Channel and Stellwagen Bank in the vicinity of commercial and recreational fishing vessels and whale watch boats. During the early 1970s, before whale watching became popular in Massachusetts Bay, humpback whales were difficult to approach in a small boat (Watkins 1986). The whales usually diminished surface activities and moved away, emitting agonistic trumpeting sounds when approached too closely. However, during recent years humpback whales in nearshore waters often readily accept the presence of vessels, and some even "perform" various surface behaviors when approached by a whale watch vessel. Humpbacks in the western North Atlantic are more habituated to vessel approach than any other cetacean in the area (Watkins 1986). As whales become more habituated to whale-watch and other vessel traffic, the chance of collision increases (Beach and Weinrich 1989). There is some evidence of increased incidents of ship collisions in the Gulf of Maine (NMFS 1991a). In a recent study of stranded humpback whales along the Middle-Atlantic and southeast U.S., 30% (6/20) had injuries potentially associated with a ship strike (Wiley *et al.* 1995).

Vessel traffic along the continental shelf of the northeastern U.S. can result in acoustic and physical disturbance of the environment. To date, there is little information on the reaction of humpback whales to acoustic disturbance. Humpback whales have good hearing and use vocalizations and hearing for a variety of purposes, including social interaction, orientation, and prey detection. Humpback whales produce three kinds of sounds: (1) songs that are produced in late fall, winter, and spring by solitary individuals; (2) sounds by whales within groups on the winter (breeding) grounds; and (3) sounds on the summer feeding grounds (Richardson *et al.* 1991).

Complex, long-lasting songs usually are associated with reproduction and usually are only used by males on the subtropical and tropical wintering grounds (Tyack and Whitehead 1983; Cato 1991). They are composed of complex trains of vocalizations ranging from 40 to at least 4,000 Hz (Thompson *et al.* 1979). The low-frequency components of the songs have peak source levels in the range of 144 to 174 dB re 1 μPa at 1 m (Thompson *et al.* 1979, 1986). During the summer, humpbacks make some vocalizations while feeding. Vocalizations are in the 20 to 2,000 Hz range with peak source levels of 175 to 192 dB re 1 μPa at 1 m (Thompson *et al.* 1986). The sounds are used to coordinate feeding strategies of groups of whales (Nilson *et al.* 1989).

Although little is known about hearing in baleen whales, it is generally assumed that they hear best in the frequency range of their vocalizations (Myberg 1978, 1990). Because many baleen whale vocalizations are below 1 kHz, and extending down to about 15 Hz, it is highly likely that they are very sensitive to low-frequency sounds similar to those produced by operating motor vessels. Ambient ocean noise has many low-frequency components; it is probable that ambient noise is the main limiting factor in detection of low-frequency sounds by baleen whales (Richardson *et al.* 1991). The total natural ambient noise in the open ocean is about 74 to 100 dB re 1 μPa (Richardson *et al.* 1991; McCauley 1994; Advanced Research Projects Agency 1995). Studies by Dahlheim and Ljungblad (1990) with gray whales suggest that the critical ratio (difference between the lowest detectable sound intensity at a particular frequency and the ambient noise intensity at that frequency) for baleen whales is very low (probably less than 10 to 20 dB) at low sound frequencies. Baleen whales have good directional hearing and may be able to detect low intensity, low frequency sounds when the signal and ambient noises are angularly separated (Richardson *et al.* 1991)

Baleen whales respond differently to relatively constant noises, such as ship noise, and impulsive noise, such as an explosion or seismic exploration noises. Generally, the threshold level for response in baleen whales for constant noises is 45 to 50 dB re 1 μPa lower than for impulsive noise (Malme *et al.* 1984; Richardson *et al.* 1991; McCauley 1994; Advanced Research Projects Agency 1995). Bowhead whales have been observed responding to vessel propeller noises of 84 and 91 dB re μPa in the ⅓-octave bands of strongest noise (Miles *et al.* 1987). These levels were only about 6 and 13 dB above the background noise in the bands. Humpback whales in southeastern Alaska probably detected but did not respond to a received continuous sound of 116 dB re 1 μPa representing an industrial noise source (Malme *et al.* 1985). Most baleen whales respond to constant, low-frequency sounds with broad-band intensities of more than about 120 dB re 1 μPa (Richardson *et al.* 1990; Malme 1993; Malme and Krumhansl 1993; Advanced Research Projects Agency 1995). Whales probably experience pain and injury when received low-frequency underwater sounds exceed a pressure of about 170 to 180 dB re 1 μPa (Greenlaw 1987).

Motor vessel noises, caused by the turning of the screws, engine noises, and noises of operating machinery on board, generally fall in the frequency range of 5 to 2,000 Hz, with highest intensities below 100 Hz (Scrimger and Heitmeyer 1991). Sound intensity particularly at higher frequencies, tends to increase with the size of the vessel. Supertankers and large container ships may have a maximum broad-band sound source level of 190 to 200 dB re 1 μPa at 1 m (Buck and Chalfant 1972; Cybulski 1977). A motor tug boat towing a loaded barge may have a peak ⅓-octave sound pressure source level of about 170 dB re 1 μPa at 1 m (Miles *et al.* 1987). Small outboard motor vessels produce broad-band sounds of about

150 dB re 1 μPa at 1 m; these sounds are attenuated to the range of 85 to 140 dB re 1 μPa at a distance of 50 m from the source (Richardson *et al.* 1991).

Thus, humpback and other baleen whales can hear the sounds of nearby motor vessels. There is some uncertainty whether sounds of the frequencies and intensities emitted by motor vessels cause biologically significant disturbance and even harm to marine mammals. There is limited evidence that abrupt changes in vessel speed and propeller RPMs may disturb whales (Watkins 1986); however, it appears that they readily acclimate to the noise in their environment. Responses to vessel noises are highly variable for different species and even among individuals of a species (Richardson *et al.* 1991). Whales may react to short-term acoustic disturbances by moving away from the sound source, changing breathing and diving patterns, or through agonistic displays (NMFS 1991a). Some individuals, perhaps naive, may react to a motor vessel several km away (Ljungblad *et al.* 1988; MMS 1992). Bowhead whales in the Arctic often will change course and behavior when exposed to active oil well drilling rigs and impulsive sounds from seismic survey vessels (Ljungblad *et al.* 1988; Richardson *et al.* 1985, 1991); however, most cetaceans adjust rapidly to the presence of underwater sound from vessels and from offshore oil well drilling (Geraci and St. Aubin 1987). To date there is no conclusive evidence that short-term disturbance from underwater noise of the frequencies and intensities produced by motor vessels leads to any long-term effects on individuals or populations (Richardson *et al.* 1991).

Humpback whales are the top carnivores in a relatively simple food chain consisting of phytoplankton, zooplankton, small forage fish and crustaceans, humpback whales. Although the chain is short, it does afford a mechanism for accumulation of natural and anthropogenic toxins to high concentrations from food through trophic transfer and biomagnification.

An example of this phenomenon occurred in late November, 1987, when 14 humpback whales died in Cape Cod Bay and Nantucket Sound after eating Atlantic mackerel containing a dinoflagellate toxin, saxitoxin (Geraci *et al.* 1989). A few species of dinoflagellates, microscopic plants (phytoplankton), produce powerful neurotoxins. These phytoplankton may periodically experience an explosive increase in population size (called a bloom) in restricted locations along the coast. Primary consumers consume the toxic blooms and may accumulate high concentrations of the toxins, leading to outbreaks of paralytic shellfish poisoning (when commercially exploited bivalves consume the phytoplankton). The primary consumers may be resistant to the toxins or may not accumulate doses that are toxic to themselves. However, secondary or higher level consumers that eat the contaminated primary consumers may accumulate a toxic or lethal dose. This is apparently what happened to the humpback whales. The evidence accumulated by Geraci *et al.* (1989) suggests that a northern stock of mackerel, that had accumulated saxitoxin while feeding on their preferred food of zooplankton and small fish in the Gulf of St. Lawrence, migrated into Massachusetts and Cape Cod Bays, where they were consumed by humpback whales. Some of the whales received a lethal dose of neurotoxin and died almost instantly while still feeding. Although this is the first documented case in the world of a large kill of humpbacks or other whales attributable to ingestion of foods contaminated with phytoplankton toxins, it is possible that periodic mortalities of 1 or a few whales were caused by phytotoxins, but went unrecorded. During the first six months of 1990, seven juvenile (7.6 to 9.1 m) humpback whales stranded on the shore between North Carolina and New Jersey with no apparent cause of death (NMFS 1991b). The young whales may have been killed by consuming saxitoxin-contaminated food.

Some nonpolar organic contaminants, such as chlorinated pesticides and polychlorinated biphenyls (PCBs), could also be biomagnified through the marine food web and be accumulated to high, potentially toxic concentrations in the tissues of humpback whales and other piscivorous cetaceans (Reijnders 1986;

Aguilar 1987). There are only limited published data on contaminant residues in tissues of northwest Atlantic humpback whales (Taruski *et al.* 1975; Geraci 1989). Concentrations of synthetic organochlorines in blubber of 4 humpback whales from the western North Atlantic stock (Geraci 1989) were higher than concentrations of organochlorines in blubber of several other Atlantic baleen whales, including right whales (Woodley *et al.* 1991), fin whales (Aguilar and Borrell 1991; 1994), and sei whales (Aguilar and Borrell 1991). The lower organochlorine residues in right and sei whales probably are caused by the lower trophic status of these zooplankton-feeding species. The lower residues in fin whales may be due to geographic differences; the fin whales were sampled at a whaling station in northwestern Spain and the humpback whales were collected in U.S. waters of the northwestern Atlantic.

Accumulated organochlorines may lead to a variety of pathological conditions in cetaceans, in particular reproductive impairment (Addison 1989). In addition, nonpolar organic contaminants, that tend to accumulate in depot lipids, such as blubber, while the whale is feeding, may be mobilized during fasting (female humpback whales are not known to feed when they are in the winter calving grounds) and accumulate in the lipid rich milk when the female whale is lactating and nursing its newborn calf (Aguilar 1987; Aguilar and Borrell 1994).

3.2 The Fin Whale (*Balaenoptera physalus*)

3.2.1 Population Status and Trends

Fin whales (*Balaenoptera physalus*) are long and slender, growing to a maximum size of about 27 m (88 ft) and 73,000 kg (Minasian *et al.* 1984). As with most cosmopolitan whales, animals from the southern hemisphere tend to grow to larger size than those in northern hemisphere populations (Slijper 1978), and females usually are larger than males. The largest fin whale sighted in the northwest Atlantic during the CeTAP program was 21.6 m long and the average size of adult whales was 16.1 m (Hain *et al.* 1992).

The U.S., Nova Scotia, and Labrador stocks of fin whales are from one or a few closely related populations, whereas the Icelandic population is distinct (Mitchell 1974; Donovan 1991). Observations of fin whales from the U.S., Canada, and Iceland indicate that the average size of fin whales from more northern Atlantic waters off Canada and Iceland is larger than that of fin whales sighted off the U.S. North Atlantic coast. Sergeant (1977) suggested that stocks of fin whales along the North American coast may be segregated latitudinally by length during at least part of the year. Because little is known about the winter breeding and calving areas of fin whales, it is uncertain whether fin whales, like humpback whales, segregate into a few separate breeding populations that form several distinct summer feeding aggregations occupying different feeding grounds.

Fin whales were listed as endangered throughout their range in 1970. Because of their high cruising speed, fin whales were not harvested commercially in large numbers until other, easier to catch species, such as right whales, were depleted and whalers developed high-speed boats (Leatherwood *et al.* 1976). However, more than 700,000 fin whales were harvested world-wide in the twentieth century (NMFS 1994). There was a fishery for this species in Nova Scotia, from 1964 to 1972 (Mitchell 1974) which harvested more than 3,000 individuals during its short life. Commercial harvesting of fin whales elsewhere in the world has continued at least into the early 1990s. However, stocks of fin whales have not been as severely depleted as those of right and humpback whales by commercial whaling.

Fin whales are present in all the major oceans of the world from the Arctic to the tropics, with greatest numbers in temperate and boreal latitudes (Evans 1987). The estimated modern world-wide population is 105,000 to 125,000 individuals (Würsig 1990). They are the most abundant and frequently sighted of the endangered great whales that visit coastal waters of the northeastern United States. The size of the population in outer continental shelf waters off the eastern United States from Cape Hatteras to the Canadian border ranges from about 5,000 in the spring and summer to about 1,500 in the fall and winter (Hain *et al.* 1992). Mitchell (1974) estimated that approximately 7,200 fin whales occupy the outer continental shelf between Cape Cod and Labrador on a seasonal basis. About 2,000 fin whales visited Newfoundland waters each year in the early 1970s (Allen 1974), but the number seems to have dropped during the 1980s (Lynch and Whitehead 1984). The portion of the northwest Atlantic population that visited the Gulf of Maine in the late 1970s and early 1980s range from about 3,000 individuals in the spring and summer to 200 individuals in the fall and winter (CeTAP 1982). The current population size in the Gulf of Maine probably is larger than the CeTAP (1982) estimates.

The size of the pre-exploitation population of fin whales in the western North Atlantic Ocean probably was between 30,000 and 50,000 individuals (CeTAP 1979). Hain *et al.* (1992) suggested that the 1992 population of fin whales off the northeast coast of the United States might be in the range of 9,000 to 10,000 animals. Thus, the North Atlantic fin whale population has recovered to about ¼ to ⅓ its pre-exploitation size.

Little is known about reproduction in North Atlantic fin whales. Presumably, reproduction takes place during their winter sojourn off the mid- and south-Atlantic states. Based on the distribution of strandings of neonates, some of which were premature, calving seems to take place in coastal or offshore waters south of New Jersey between October and January (Hain *et al.* 1992). Hain *et al.* (1992) hypothesized that the Charleston Bight south of Cape Hatteras is the wintering ground for some of the fin whale population that occupies New York Bight and New England waters during the summer. No mating or breeding is known to occur in the Gulf of Maine and Canadian waters.

Newborn fin whales are just under 8 m long (Hain *et al.* 1992). Typically, the rapidly-growing calves are weaned after seven months to as much as one year. Like most baleen whales, fin whales may have a calf every two years. Female fin whales that summer in the Gulf of Maine have an average of 1 birth every 2.71 years (Agler *et al.* 1993). The average rate of increase in the size of the northwestern Atlantic fin whale population is approximately 8% per year (Agler *et al.* 1993). Females reach sexual maturity after as little as 4 to as many as 7 years, apparently depending on availability of food (Ohsumi 1986). The size at sexual maturity is about 15-16 m. Fin whales may live as long as 85 or 90 years (Evans 1987).

3.2.2 Seasonal Distribution in Middle-Atlantic Bight Waters

In spring and summer, approximately 5,000 fin whales occupy the continental shelf between Cape Hatteras and the Canadian border; numbers there decrease to about 1,500 during the fall and winter each year (Hain *et al.* 1992). Thus, fin whales are by far the most abundant baleen whales in coastal waters of the middle Atlantic (Figure 5). They are most abundant along the 40 to 50-m depth contour, particularly in the Great South Channel, across Stellwagen Bank and northeastward to Jeffreys Ledge (Hain *et al.* 1992). They are common in waters out to the shelf edge, 200 m, but rarely are sighted in waters deeper than 2,000 m. Sixty-five percent of sightings are in water depths of 21 to 100 m. The summer distribution of fin whales is very similar to that of humpback whales, and the two species can be considered sympatric throughout much of their range in U.S. waters of the Atlantic during the summer feeding season.

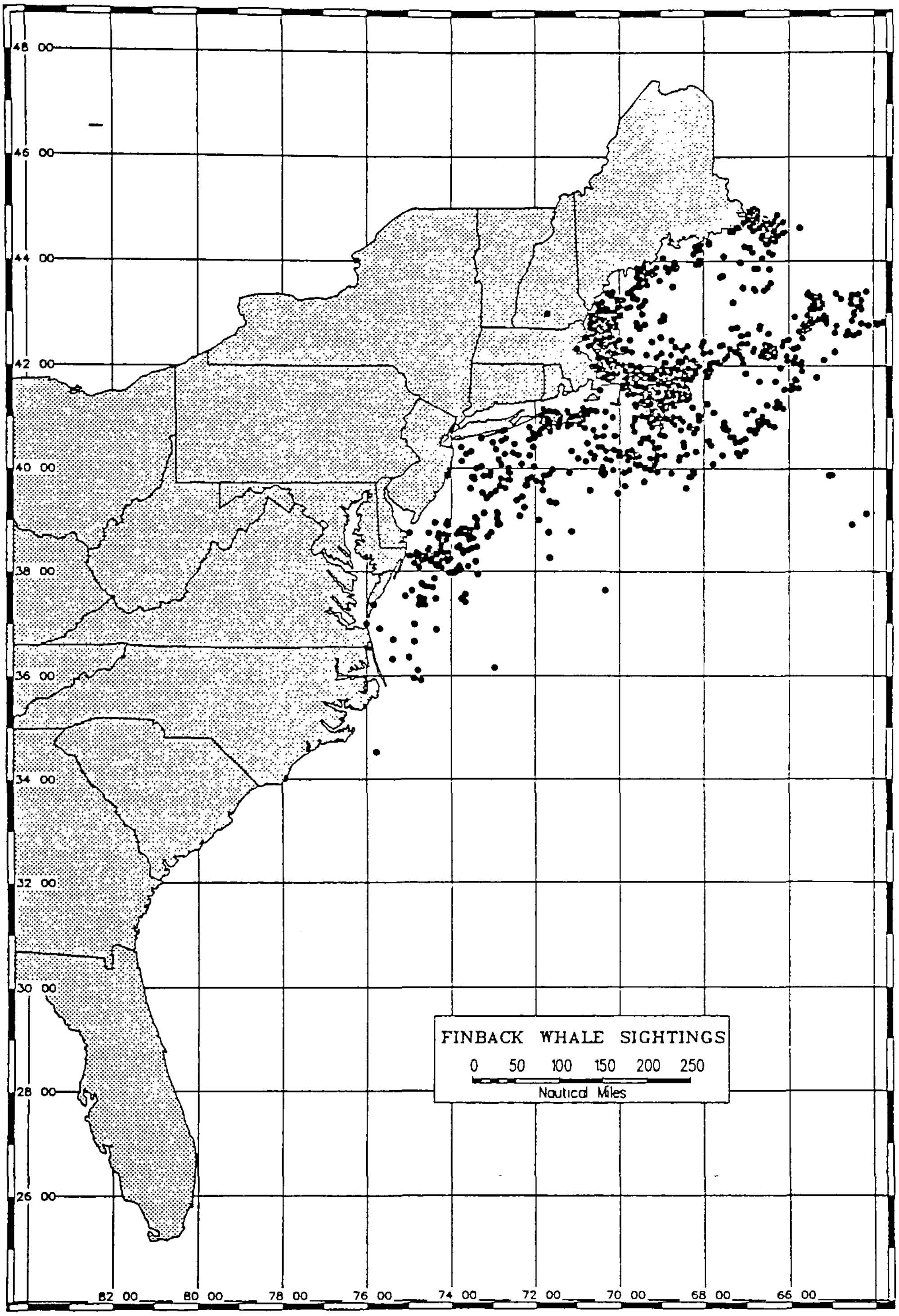

Figure 5. Distribution of Fin Whales 1960 - 1992 in the Northwest Atlantic (Source: NMFS unpublished data).

Fin whales are the most abundant baleen whales in the New York Bight and are present year round (Sadove and Cardinale 1993). In January through March, they are found close to shore (within 1 mile) off eastern Long Island where they probably are feeding on herring and mackerel (Sadove and Cardinale 1993; USACE 1993). They are also found in relatively large numbers in the New York Bight Apex during January and February (CeTAP 1982). They move away from the apex beginning in March and spread throughout the Bight during the summer in feeding groups that may involve aggregations of more than 20 individuals and occasionally as many as 200 individuals. Some fin whales that wintered in the Bight may move northward to rich feeding grounds off New England during the summer (Payne and Heinemann 1990). Other whales from further south may move into the bight in the spring. About 87% of all fin whale sightings in the New York Bight occur between April and October in waters off eastern Long Island (Sadove and Matlock-Cooley 1990). From September through early December, the fin whales usually move offshore to the edge of the continental shelf near the 200-m contour. They congregate in largest numbers in waters adjacent to the Hudson Canyon where small schooling forage fish may be abundant. They feed there in smaller aggregations of three to four individuals.

All age classes are represented in the fin whale populations in the New York Bight throughout the year. Mother-calf pairs are observed in the New York Bight throughout the year and some calving may actually occur in the Bight (Sadove and Kiehn 1984).

Many of the fin whales that occupy coastal waters north of 40°N latitude during the summer move south and offshore, starting in October, to wintering grounds off Long Island, the Delmarva Peninsula, the Outer Banks of North Carolina (CeTAP 1982; EPA Region 1 1988), and perhaps further south. Hain *et al.* (1992) speculate that the large numbers of fin whales sometimes sighted in waters off Cape Hatteras in spring and fall are moving between northern summer feeding grounds and southern overwintering grounds in the Charleston Bight off South Carolina. However, very few surveys have been performed in this area, so it is uncertain if fin whales actually occur there in large numbers during the winter.

Fin whale calves arrive in the summer feeding areas in the New York Bight, off New England, and eastern Canada with their mothers. Even after separation from their mothers, which usually takes place after about a year, most juveniles return to the same feeding areas they first visited with their mothers, suggesting that migratory behavior and preferred feeding locations are learned from the mother (Seipt *et al.* 1990; Clapham and Seipt 1991).

Fin whale distributions have changed somewhat in recent years, similar to the changes observed for humpback whales. Both species feed on similar species and changes in seasonal distributions reflect changes in the relative abundance and distribution of certain forage species, such as sand lance and herring (Payne *et al.* 1996; Fogarty *et al.* 1991).

3.2.3 Food and Feeding Behaviors

Fin whales eat many of the same foods as humpback whales and the two species frequently are seen feeding together in spring/summer feeding areas (CeTAP 1982). Other species of cetaceans that frequently are seen feeding with fin whales are minke whales (*Balaenoptera acutorostrata*) and whitesided dolphins (*Lagenorhynchus acutus*).

Fin whales feed on a wide variety of small schooling fish and crustaceans. Since the mid 1970s, the favorite food of fin whales on Stellwagen Bank, in Massachusetts Bay, and probably also in the New York Bight is sand lance (Overholtz and Nicolas 1979; McKenzie and Nicolas 1988). In coastal waters off

Newfoundland, they feed primarily on capelin (Piatt *et al.* 1989). North Atlantic populations also have been reported to feed on euphausiids, copepods, squid (*Loligo* spp. and *Ilex* spp.), and myctophid fish, when these are locally abundant (Mitchell 1974; Katona *et al.* 1977).

Brodie *et al.* (1978) reported that a 17.8-m fin whale caught off Nova Scotia contained approximately 560 kg of euphausiids in its forestomach, probably having eaten more than that amount in less than eight hours. Hain *et al.* (1992) estimated that a "typical" 25.7-ton fin whale eats about 533 kg of prey daily during the summer feeding period. He estimated that the entire fin whale population of the northeast coast of the U.S. consumes about 150,000 metric tons of prey during the fall and winter and 494,000 metric tons of food during the more active spring and summer feeding periods. Baleen whale populations, including fin whales, off Newfoundland may consume about 400,000 metric tons of capelin each year (Winters 1975). A similar amount of food may be consumed by baleen whales on Georges Bank (Hain *et al.* 1985). Thus, fin whales have an important effect on the pelagic marine ecosystem of the western North Atlantic.

Fin and humpback whales probably compete directly with cod, haddock, other piscivorous ground fish, and man for food (Overholtz and Nicolas 1979; Hain *et al.* 1985). Hain *et al.* (1992) estimated that the amount of food eaten by baleen whales each year was equivalent to the amount harvested by man. However, Piatt *et al.* (1989) estimated that fin, humpback, and minke whales consumed less than 2% of the available capelin during heavy feeding in Witless Bay, Newfoundland. The large breeding population of seabirds in the area probably consumed more capelin than the whales. The three species of whales consumed 60 to 100 metric tons of capelin each year from the bay, with the less abundant fin whales taking about 6.6 to 11 tons, and the more abundant humpback whales taking 47 to 80 tons per year. These observations suggest that, although fin and humpback whales do compete for some of the same foods with some commercially valuable groundfish, the available food resource is not limiting to either group of consumers.

Feeding behaviors of fin whales are less well known than those of right and humpback whales. They seem to feed singly, or in groups of 2 to as many as 50 animals (CeTAP 1982). Fin whales are streamlined, fast swimmers that typically cruise at speeds of 5 to 10 km/h (Hain 1991b). They apparently use this speed to feed on less dense, more widely separated patches of prey items than required by humpback whales (Whitehead and Carlson 1988). However, the observations of Brodie *et al.* (1978) on amounts of euphausiids in the stomachs of fin whales suggest that fin whales do focus their feeding efforts on dense aggregations of prey, when these are available.

Lunge-feeding fin whales usually move rapidly parallel to the water surface, whereas lunge-feeding humpback whales usually swim at an acute angle to the sea surface (Watkins and Schevill 1979). Typically, a fin whale approaches a school of fish or euphausiids at a speed of 5 to 11 km/h (Orton and Brodie 1987). It waits to open its mouth until close to or in the school (Watkins and Schevill 1979). It opens its mouth to an angle of 10° to 30°, depending on the size of the school, and closes it slowly over a period of 1 to 3 seconds, engulfing a massive volume of water as it continues to swim forward. The grooved pouch forming the floor of the mouth of fin whales is extremely elastic and can extend tremendously during feeding, allowing the mouth to accommodate a large amount of water, equivalent to as much as 50% of the volume of the whale (Pivorunas 1979; Orton and Brodie 1987). The force of water rushing into the open mouth causes the elastic pouch to expand, often doubling the diameter of the whale. The rapid expansion of the mouth cavity allows water to enter with minimal disturbance, avoiding a bow wave that might allow prey to escape. After the whale closes its mouth, a complex network of muscles lining the grooved pouch contracts slowly, compressing the water and forcing it out through the baleen plates on either side of the jaws. The food retained by the baleen then is swallowed slowly through the small throat.

3.2.4 Known Disturbance and Mortality Factors

There is very little published information about natural and anthropogenic causes of death and disease in fin whales. It is probable that the hazards that affect humpback whales also affect fin whales. Fin whales often are caught in fish traps deployed in offshore Canadian waters. Between 1969 and 1986, 12 fin whales were entangled in fishing gear, usually groundfish gill nets, in inshore waters of Newfoundland (Hofman 1990). Five of these whales (42%) died. Between 1975 and 1990, three fin whales were observed entangled in fishing gear in the Gulf of Maine (Volgenau and Kraus 1990). All entanglements were in lobster gear. The commercial lobster industry reported 6 instances of fin whale entanglements in lobster gear between November 1975 and January 1991 (NMFS 1994). All but 1 of the whales was alive when sighted. Three of the entangled whales were sighted in Massachusetts, 2 in New York, and 1 in Maine. Such entanglements may indicate that fin whales sometimes feed near or at the bottom.

The types of passive fishing gear most frequently involved in entanglements of cetaceans (Read 1994) are generally not used in the Study Area. Lobster traps of the types used in the vicinity of the Study Area are occasionally involved in fin whale entanglements but usually do not result in serious injury to the whales. With respect to entanglement associated with placement of Material for Remediation, no impacts are expected to whales because project placement buoys are expected to be taut-line mooring configurations and avoided by fin whales.

Fin whales seem to be the most wary of the great whales when approached by whale watch boats and other vessels in Massachusetts Bay (Watkins 1986). Fin whales react strongly to low-frequency ship sounds which are near the frequency of their own vocalizations (14 to 750 Hz) (Cummings *et al.* 1986; Watkins *et al.* 1987). In the early 1970s, they actively avoided approaching vessels and would often dive if approached. In recent years, they have either ignored small vessels or actually approached to investigate them. Although they have become accustomed to small vessel activity in recent years, they apparently are not often harmed by it. However, failure to avoid vessels may put them at greater potential for injury from propellers or collisions. The sensitivity of fin whales to underwater sounds of motor vessels probably is the same as that of humpback whales, discussed previously.

There have been 72 verified strandings and 9 "floaters" of fin whales along the U.S. Atlantic coast during this century (Hain *et al.* 1992). The years with the highest number of strandings were 1983, with 12 strandings, and 1986, with 6 strandings. Strandings have occurred most often on Cape Cod, Cape Hatteras, and Long Island. All strandings of neonates (less than 8 m long) occurred south of New Jersey. The cause of death of most of these whales is unknown. However, a yearling female fin whale stranded in New England in 1977 apparently died of a massive infection of giant nematode parasites (*Crassicauda boopis*) in the kidneys (Lambertsen 1986). This parasitic disease has a prevalence of nearly 95% in the Icelandic population of fin whales and appears to be very common in other fin whale stocks as well (Lambertsen 1986). The parasite may cause renal failure and mild anemia in severely infected whales. It may be passed from mothers to their suckling calves in the urine (the urethral opening and the mammary grooves are close together in most whales). Lambertsen (1986) suggested that crassicaudiosis is a major natural cause of mortality in fin whales.

At the time in 1987 when 14 humpback whales died from consumption of mackerel contaminated with phytoplankton toxin, two partly decomposed fin whales washed up on the western shore of Cape Cod Bay at Marshfield and Manomet, MA (Geraci *et al.* 1989). The cause of death was not determined, but could have been consumption of the contaminated fish. Fin and humpback whales eat similar foods.

Fin whales are the fastest swimmers of the baleen whales. Therefore, it is unlikely that predation by killer whales and large sharks is an important cause of injury and death, except possibly among the very young or sick. Nevertheless, there have been a few reports in the literature of attacks by killer whales on fin whales (Tomlin 1957).

Their high speed also seems to protect them from collisions with motor vessels. The Smithsonian Institution Marine Mammal Database contains nine records of collisions or propeller scaring of fin whales between 1980 and 1994 (NOAA 1995c). Several of the documented and photographed fin whales in the western North Atlantic population have prominent scars indicative of boat collisions (Agler *et al.* 1990; Seipt *et al.* 1990).

Like most large whales, fin whales do not seem to be particularly sensitive to spilled oil. Following a spill of nearly 8 million gallons of heavy bunker C fuel oil from the tanker *Argo Merchant* on Nantucket Shoals in 1976, large numbers of whales, including 21 fin whales, were observed in the area of the oil slick (Grose and Mattson 1977). Two fin whales were seen in a heavily oiled area and apparently were not bothered by the oil. None of the whales showed obvious distress from coming in direct contact with the oil. Following another spill of bunker C and No. 2 fuel oils from the *Regal Sword* southeast of Cape Cod, fin whales were observed surfacing in heavy slicks with no apparent adverse effects (Goodale *et al.* 1981).

There is limited information on concentrations of anthropogenic chemical contaminants in the tissues of fin whales (Taruski *et al.* 1975; Wagemann and Muir 1984; Aguilar and Borrell 1991). Blubber of fin whales harvested off Spain contained 100 to 1,000 µg/kg lipid weight (parts contaminant per billion parts lipid) total DDT and up to about 1,800 µg/kg lipid total PCBs (Aguillar and Borrell 1991). Females contained lower concentrations of these organochlorines than males, probably due to transfer of these lipophilic compounds to embryos during gestation and to calves in the lipid-rich milk (Aguilar 1987). These concentrations are higher than those reported by Woodley *et al.* (1991) for right whales from the western North Atlantic, but are comparable to concentrations in other fish-eating baleen whales (Tarsuki *et al.* 1975; Wagemann and Muir 1984). Blubber from Icelandic sei whales (planktivorous) analyzed by Aguilar and Borrell (1991) contained about half the concentrations of total DDT and PCB of blubber from fin whales. The differences probably related to differences in the feeding habits of the two cetaceans.

3.3 The Loggerhead Turtle (*Caretta caretta*)

3.3.1 Population Status and Trends

The loggerhead sea turtle (*Caretta caretta*) is listed as threatened under the Endangered Species Act. It is the most common and seasonally abundant turtle in inshore coastal waters of the Atlantic. An estimated 7,000 and 10,000 individuals of both sexes of this turtle occur seasonally in coastal waters of the north and middle Atlantic (CeTAP 1982; Shoop and Kenney 1992). However, these numbers were not corrected for the time loggerheads spend on the surface. Radiotagging experiments have shown that loggerheads spend about 2.3 minutes out of each hour on the surface (3.8%) (Thompson 1988). Aerial surveys performed by the National Marine Fisheries Service between Cape Hatteras, NC and Key West, FL between 1982 and 1984 were corrected for submergence time and yielded an estimated peak abundance of 387,594 (±20,154, 95% CI) individuals with carapace lengths of 60 cm or greater (Thompson 1988). The abundance of loggerhead turtles is much lower north of Cape Hatteras and nearly all the turtles that visit northern waters during the summer are juveniles with carapace lengths less than about 60 cm (Morreale and Standora 1993).

Most nesting in U.S. territory occurs on sandy shores between North Carolina and Key Biscayne, FL. Between 1980 and 1983, an annual average of 52,073 (±16,459, 95% CI) nests were excavated by females (Thompson 1988). An additional 1,000 nests were excavated along the entire U.S. coast of the Gulf of Mexico. At an average of 2.5 nests per female per year, these numbers indicate that more than 20,000 loggerhead turtles nest along the Atlantic and Gulf of Mexico coasts of the United States each year. There is some evidence of a small decline in the population of nesting females along the south Atlantic coast in recent years (Witherington and Ehrhart 1989).

The estimated population of loggerhead turtles along the southeast coast of the United States remained relatively stable at about 387,000 individuals during the 1980s (Thompson 1988). An estimated 10,000 to 23,000 loggerheads are killed by fishing activities, particularly entanglement in shrimp trawls, along the Atlantic and Gulf of Mexico coasts each year before the introduction of turtle excluder devices (TEDs) (Henwood and Stuntz 1987). Crowder *et al.* (1994b) estimated that implementation of TED regulations has resulted in a decline of about 5% to 6% per year in loggerhead strandings. Recent models indicate that it may take up to 70 years or more of deployment of TEDs on shrimp trawls for an increase in the numbers of nesting females to become evident (Crowder *et al.* 1994a).

3.3.2 Seasonal Distribution In Middle-Atlantic Bight Waters

Loggerhead turtles are abundant during spring and summer months in coastal waters off New York and the middle Atlantic states. In the fall, they migrate southward to coastal waters off the south Atlantic states, particularly Florida, and the Gulf of Mexico. In the spring, they congregate off southern Florida before migrating northward to their summer feeding ranges (CeTAP 1982). During the winter, the turtles tend to aggregate in warmer waters along the western boundary of the Gulf Stream off Florida (Thompson 1988).

During their first two to five years, juvenile loggerheads are pelagic, drifting and feeding in the *Sargassum* community (Carr 1986a,b). During this long pelagic period, the young turtles may make several transits of the North Atlantic Ocean in the Great Gyre of the Gulf Stream and grow from a newly hatched size of 4.5 cm to about 40 cm before moving into coastal waters (Dodd 1988).

At an age of two to five years old, juvenile loggerheads begin appearing in coastal waters of the middle Atlantic, particularly in coastal bays of the New York Bight and Chesapeake Bay (Morreale and Standora 1993). They apparently migrate north to these feeding areas in the spring and early summer.

The center of distribution of juvenile loggerheads along the U.S. Atlantic coast is in central Florida off Cape Canaveral (Schmid 1995). Many of the young turtles migrate northward during the spring and early summer to more northerly nearshore feeding areas, such as Core Sound, North Carolina (Epperly *et al.* 1995a,b), southern Chesapeake Bay (Keinath *et al.* 1987; Schmid 1995), and Gardners Bay and Long Island Sound, New York (Morreale *et al.* 1989; Shoop and Kenney 1992; Morreale and Standora 1993). Between 2,000 and 10,000 sub-adult loggerhead turtles use Chesapeake Bay south of the Potomac River for feeding during the summer (Keinath *et al.* 1987). Smaller numbers are encountered particularly in July, in Delaware Bay (Eggers 1989). Loggerheads also are encountered frequently in Long Island Sound, New York Harbor-Raritan Bay, and along the south coast of Long Island during the summer (Morreale *et* *al.* 1989). Loggerheads frequently strand due to cold stunning between November and January each year along the north shore of Long Island Sound and in the Bays of eastern Long Island (Morreale *et al.* 1992). When the water temperature drops below about 12°C, the metabolic rate of these cold-blooded reptiles decreases to the point where they are unable to swim and digest food; they become comatose and may die if not warmed quickly. Loggerheads occur only rarely north of Long Island around Cape Cod and in the Gulf of Maine (Shoop and Kenney 1992) (Figure 6). Several sub-adult loggerheads strand along the south shore of Cape Cod Bay each winter (Matassa *et al.* 1994). The stranded turtles measure 27 to 47 cm SLCL (straight line carapace length), indicating that they are late juveniles.

Migratory behavior seems to be cued to sea surface temperatures, with preferred water temperatures off Cape Hatteras falling in the range of 14°C to 28°C (Shoop and Kenney 1992; Coles *et al.* 1994). Loggerhead turtles first appear in waters around Long Island, New York, in early June and remain in New York waters, mostly in bays in eastern Long Island, for the entire summer (Morreale and Standora 1993). They begin to leave New York waters, swimming first eastward and offshore and then southward, in late September through mid-October each year. Nearly all loggerheads remaining in New York waters after the beginning of November are cold-stunned. The cold stunned turtles apparently are not the same turtles that reside in local waters during the summer. They probably are from more northern, Massachusetts Bay and Nantucket Shoal, feeding groups that were caught by rapidly declining water temperatures during their southward migration (Morreale and Standora 1993).

The center of distribution of loggerhead turtles in the New York Bight area is in coastal bays in eastern Long Island and in eastern Long Island Sound (Morreale and Standora 1993). They may also be abundant along the south shore of Long Island, particularly in mid-shelf waters south of central Long Island, and in the New York Bight Apex (Morreale *et al.* 1989; Shoop and Kenney 1992).

In the fall, loggerheads migrate southward to coastal waters off the south Atlantic states, particularly from Cape Hatteras, North Carolina, to Florida, with peak numbers passing Cape Hatteras in November (Morreale and Standora 1993; Musick *et al.* 1994). Some juvenile loggerheads remain through the winter in nearshore waters of North Carolina south of Cape Hatteras where water temperatures remain at or above 11°C (Epperly *et al.* 1995b). In the winter and spring, they congregate off southern Florida before migrating northward to their summer feeding ranges (CeTAP 1982). Peak numbers of northward-migrating sub-adult loggerheads occur off Cape Hatteras in April and May each year (Musick *et al.* 1994). During the winter, the turtles tend to aggregate in warmer waters along the western boundary of the Gulf Stream off Florida (Thompson 1988). They also may hibernate in bottom waters and soft sediments of channels and inlets along the Florida coast (Ogren and McVea 1981; Butler *et al.* 1987).

3.3.3 Food and Feeding Behaviors

Adult loggerheads are primarily bottom feeders, foraging in coastal waters for benthic molluscs and crustaceans (Bjorndal 1985). During feeding, they spend more than 57 minutes of each hour submerged (Thompson 1988). Sub-adult loggerheads collected in Chesapeake Bay contained in their stomachs horseshoe crabs, cancer crabs, and blue crabs, with traces of *Sargassum* weed (Lutcavage 1981). In New York coastal waters, they feed primarily on small benthic crabs, such as spider crabs, rock crabs, and green crabs (Burke *et al.* 1990; Morreale and Standora 1992, 1993). Loggerhead turtles stranded on Cumberland Island, Georgia, had been feeding on a variety of crabs, whelks, and mantis shrimp (Ruckdeschel and Shoop 1988). Some turtles had large numbers of barnacles in their stomachs. Although loggerheads appear to feed primarily on the bottom on benthic invertebrates, they also take food from the water column

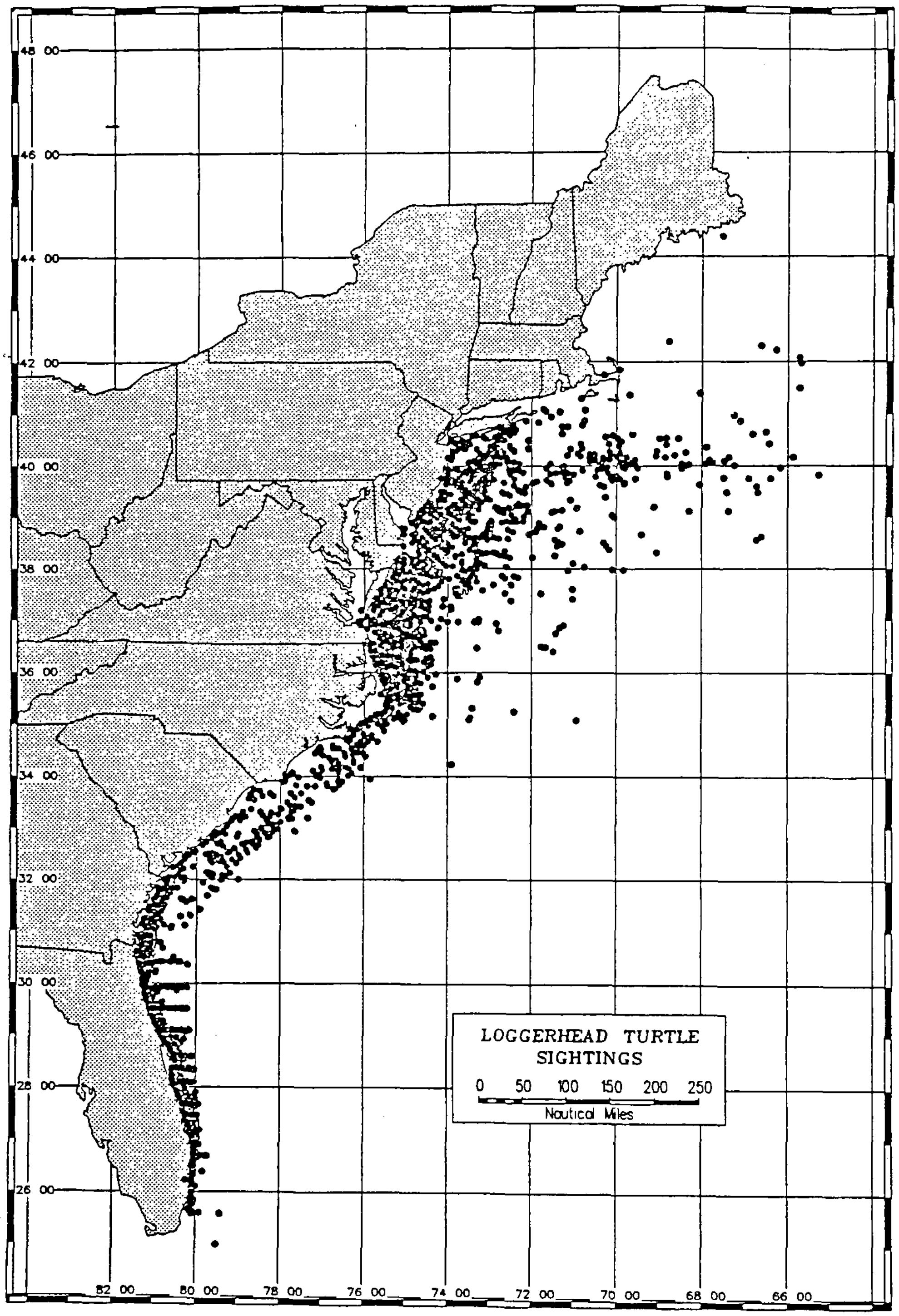

Figure 6. Distribution of Loggerhead Turtles 1960 - 1992 in the Northwest Atlantic (Source: NMFS unpublished data).

or the water surface. Turtles frequently contain large amounts of sediment in their guts, probably ingested during feeding on benthic prey (Ruckdeschel and Shoop 1988).

In the New York Bight area, nearly all sightings of juvenile loggerheads (the only life stage present) are in shallow coastal bays and estuaries where the turtles feed on benthic invertebrates, particularly crabs (Morreale and Standora 1993). They rarely are observed in water depths of 20 m or more, characteristic of most of the current MDS and proposed HARS (refer to Figure 1), and rarely feed at depths greater than about 15 m. Therefore, there is little likelihood that juvenile loggerhead turtles feed within the affected environment of the Proposed Action or the alternatives.

Juvenile loggerhead turtles grow rapidly during their summer visits to coastal waters of the New York Bight (Morreale and Standora 1993). The increase in straight-line carapace length of juvenile turtles in New York ranges from 10.6 cm/year for 40- to 50-cm individuals to 3.0 cm/year for 50- to 60-cm individuals. These growth rates are slightly lower than those of loggerheads in Florida and the Bahamas (Mendonça 1981; Bjorndal and Bolten 1988). Schmid (1995) estimated, based on tag-recapture studies, that loggerheads along the east coast of central Florida grow at a rate of 5.56 cm/year. Growth rate slows as the turtles approach sexual maturity, which may occur after 12 to 45 years in the wild (Zug *et al.* 1983; Frazer and Ehrhart 1985; Foster 1994) when the turtles are about 74 to 90 cm SLCL (Dodd 1988; Foster 1994). Adult loggerheads from the Florida population may grow to more than 120 cm SLCL and weight more than 180 kg (Ehrhart and Yoder 1978). The good growth of juvenile loggerhead turtles in New York waters suggests that the turtles are not casual visitors to these northern habitats, but visit coastal bays and nearshore waters of the region intentionally each summer to feed and grow (Morreale and Standora 1993).

3.3.4 Known Mortality Factors

Between 1980 and 1983, there were 6,691 reported strandings of loggerhead turtles along the U.S. Atlantic and Gulf of Mexico coasts (Thompson 1988). Most strandings (77%) were along the southeast coast from North Carolina to Florida; about 11% of strandings occurred north of Cape Hatteras. Most strandings occurred during the spring and summer; 79% of the strandings north of North Carolina were between April and July. The causes of these strandings has not been determined.

There have been five to 27 strandings each year along the coasts of New Jersey and New York (Teas and Martinez 1989, 1992; Teas 1992, 1993, 1994a,b). In most years, strandings in New Jersey are most frequent between July and November. Strandings occur most frequently in New York along the north shore of Long Island in the fall and winter; these strandings may be caused by cold stunning (Morreale *et al.* 1992; Matassa *et al.* 1994). As with most marine turtles, prolonged exposure of loggerheads to low water temperatures, below about 8°C, may result in dormancy, shock, and death. During the winters of 1985, 1986, and 1987, 28 loggerhead turtles became cold-stunned and washed ashore in the Bay system of eastern Long Island and along the north shore of the island (Morreale *et al.* 1992). The turtles became cold-stunned between early November and late January each year. Cold stunning is not restricted to the northern U.S. Cold stunning incidents, involving loggerhead and green turtles, have been documented several times in the northern part of the Indian River Lagoon system in east central Florida (Witherington and Ehrhart 1989; Schroeder *et al.* 1990).

The major sources of mortality of sea turtles, including loggerheads, caused by human activities include incidental take in bottom trawls, particularly shrimp trawls (Henwood and Stuntz 1987; Thompson 1988; NRC 1990; Anonymous 1992), coastal gill net fisheries, marine debris, and channel dredging (Thompson

1988; NMFS 1992). Loss of nesting habitat along the south Atlantic coast caused by coastal development probably also has slowed recruitment of sea turtles.

Shrimp fishing is the best quantified and probably the dominant source of anthropogenic mortality among North Atlantic loggerhead turtles (Thompson 1988; NRC 1990). An estimated 7,913 to 18,148 loggerheads are killed each year in shrimp nets along the southeast coast of the United States. An additional 3,555 to 4,716 loggerhead turtles are killed this way each year in the Gulf of Mexico, bringing the total killed in the shrimp industry to approximately 10,000 to 23,000 individuals per year. The National Research Council (1990) estimated an annual mortality of loggerheads due to the commercial shrimping of 5,000 to 50,000 individuals in U.S. waters.

Other fisheries account for 500 to 5,000 mortalities per year (NRC 1990). Three loggerhead turtles were reported entangled in lobster gear between 1983 and 1991 by the Sea Turtle Stranding and Salvage Network (NMFS 1994). Two of the turtles were in New Jersey and 1 was in New York. Two of the turtles died. Entanglement of loggerhead turtles is not likely to occur because project placement buoys are expected to be taut-line mooring configurations which are readily detected and avoided by loggerhead turtles.

Nationally, dredging operations (not disposal) and collisions with boats may account for an additional 50 to 500 loggerheads per year each (NRC 1990). Dickerson *et al.* (1992) reported that winter dredging of the Cape Canaveral channel, FL and King's Bay, GA resulted in the deaths of hibernating sea turtles. Entrainment in electric power plant cooling water intakes accounts for fewer than 50 loggerhead deaths per year (NRC 1990).

Ingestion of or entanglement in plastic debris undoubtedly contributes to the death of many loggerhead turtles each year; however, the magnitude of this mortality is difficult to estimate (NRC 1990). Ten percent of 33 necropsied loggerheads that had stranded in the New York Bight contained ingested synthetic materials, mostly plastics (Sadove and Morreale 1990). Loggerheads in the New York Bight become entangled most frequently in pound nets and lobster pot lines. Of 22,547 sea turtles (72.4% of them loggerheads) stranded on shores of the Atlantic and Gulf of Mexico coasts of the U.S. between 1980 and 1992, 676 (3%) were affected in some way by debris (Witzell and Teas 1994). Of the different species of sea turtles, loggerheads were least affected by entanglement; when entanglement occurred, it most frequently involved monofilament lines with fish hooks, fishing nets, and rope. More than 40 loggerheads stranded along the south Atlantic coast of the U.S. had ingested monofilament lines or hooks; a few had ingested plastic or balloons. Fourteen loggerheads stranded on the south Atlantic coast had ingested or become contaminated with oil or tar balls.

There is very little published information on the role or importance of chemical pollution in the mortality of sea turtles, including loggerhead turtles. Stoneburner *et al.* (1980) reported that loggerhead eggs collected from the shores of Florida, Georgia, and North Carolina contained 0.41 to 1.39 mg/kg dry wt. total mercury. Several loggerheads collected south of Malta in the Mediterranean Sea were contaminated with tarry residues of petroleum, probably derived from encounters with floating tar balls, which the turtles often mistake for food (Gramentz 1988). Juvenile loggerhead and Kemp's ridley turtles that stranded in Virginia and North Carolina contained 55 to 1,730 μg/kg wet wt. total organochlorines in subcutaneous fat and 7.5 to 607 μg/kg wet wt. total organochlorines in liver (Rybitski *et al.* 1995). The most abundant organochlorines were polychlorinated biphenyls (PCBs) and DDT and its degradation products.

3.4 Kemp's Ridley Turtle *(Lepidochelys kempi)*

3.4.1 Population Status and Trends

The Kemp's ridley (*Lepidochelys kempi*) is a small sea turtle; adult females have shell lengths of 62 to 70 cm and weigh 35 to 45 kg (NRC 1990). Most of the ridleys that visit the east coast of the U.S. are juveniles, averaging 25 to 30 cm long and weighing about 3 kg (NMFS 1988; NOAA 1991).

The Kemp's ridley turtle is the most endangered sea turtle in the world. The entire Atlantic population, consisting almost exclusively of juveniles, probably does not exceed 500 animals (Carr and Mortimer 1980). The total world population of adult ridleys, mostly in the Gulf of Mexico, is approximately 2,200 individuals, down from an estimated 162,400 adult individuals in 1947 (Márquez 1989). The total population, adults and juveniles, may number 22,000 to 110,000 individuals. The total nesting population of females during the mid- to late-1980s has been estimated to number about 600 individuals, with each female laying about two clutches of eggs per year (Pritchard 1990). When compared to the estimated number of nests in 1947 (92,000), this is the most severe population decline documented for any species of sea turtles (NRC 1990).

Nearly all reproduction takes place along a single 15-km stretch of beach near Rancho Nuevo, Mexico, about 322 km south of Brownsville, Texas. Nesting occurs in a highly synchronized manner with large numbers of females coming ashore within a period of a few hours during daylight (NRC 1990). In 1947, an estimated 40,000 females nested in one day on the Rancho Nuevo beach. Only 842 nests were found in 1988 (Ross *et al.* 1989). The number of nesting females has declined at a rate of about three percent per year since 1978 (Thompson 1988).

Female ridleys reach sexual maturity when they reach a carapace length of about 58 to 60 cm and are six to nine years old (Márquez 1994). The mature females nest annually and produce one to three (average about 1.7) clutches per season containing a total of about 120 to 190 eggs. Longevity probably is greater than 20 years. Little is known about the sex ratio of ridley turtles or about the life history of the males.

3.4.2 Seasonal Distribution in Middle-Atlantic Bight Waters

The Kemp's ridley sea turtle is found mainly in the Gulf of Mexico (Hildebrand 1982), but juveniles also occur during the summer along the Atlantic seaboard from Florida to Long Island Sound, Martha's Vineyard, and occasionally north of Cape Cod, in Cape Cod Bay, Massachusetts Bay, the Gulf of Maine, and as far north as the Canadian Maritime Provinces (Lazell 1980). Groups of dozens of young ridleys are observed frequently during the summer feeding in shallow coastal waters of Vineyard Sound, Buzzards Bay, MA, and in the eastern Bays of Long Island, NY (Carr 1967; Lazell 1980; Morreale and Standora 1993).

Virtually all the Kemp's ridley turtles in New York Bight waters are juveniles. It is generally thought that hatchlings and young juveniles from the western Gulf of Mexico drift to the east in the Gulf gyres and are caught in the eastern Gulf Loop Current. They are carried by the Florida Current through the Straits of Florida into the Gulf Stream, in which they are carried up the eastern seaboard of the U.S. (Collard 1987; Márquez 1994). They may be carried around the entire North Atlantic in the circular gyre of the Gulf Stream before swimming into shallow coastal waters along the Atlantic coast of the U.S. When they move into coastal waters of the New York Bight and New England, the juvenile ridleys are 24 to 30 cm long. They forage in shallow coastal waters of New England, New York, and New Jersey during the spring and summer and then migrate to southern waters in the fall. The spatial and seasonal distribution of ridley turtles in the New York Bight area is similar to that of juvenile loggerheads (Morreale and Standora 1993).

Turtles that were tagged off Cape Canaveral, FL, migrated north in the spring as water temperatures increased and south in the fall as water temperatures dropped (Henwood and Ogren 1987). The longest recorded northward migration was about 880 km. Three juvenile ridleys that were tagged and released at Virginia Beach, VA, in the fall migrated southward in nearshore waters (Keinath *et al.* 1992). One turtle got as far south as Cape Canaveral, FL, before the transmitter stopped. Two ridleys that were tagged in eastern Long Island were subsequently recaptured in coastal waters of North Carolina (Morreale and Standora 1993). A juvenile ridley turtle from eastern Long Island was tracked by satellite telemetry as it traveled south in the fall of 1991 (Morreale and Standora 1993). It traveled westward along the south shore of Long Island and then continued southwestward toward the New Jersey coast. It then swam directly south until it reached the coast of North Carolina. The entire trip of 709 km was performed within 60 km of shore in water depths less than about 40 m. The average swimming speed was 22 km/day. These studies show that ridley turtles that visit New York Bight and New England waters during the summer to feed are a part of the larger population centered in the Gulf of Mexico. These animals, despite their small size can migrate back to southern waters and are not lost to the breeding population, as had been thought earlier (Carr 1980).

All the ridley turtles in the New York Bight are two to five year old juveniles with carapace lengths of 22 to 38 cm (Burke *et al.* 1989; Morreale and Standora 1993). They begin arriving in New York waters in July or August each year and remain in shallow nearshore waters, particularly in the bays on eastern Long Island, during the summer (Burke *et al.* 1989; Morreale and Standora 1993). They begin leaving the area in mid September and most have left for warmer southern waters by the beginning of November. Some ridleys may hibernate over the winter in nearshore sediments (Carminati *et al.* 1994). Most of the ridleys observed after the beginning of November are cold-stunned. Ridleys become sluggish and have labored breathing when the temperature falls below 13°C; feeding ceases below 10°C, and they die when water temperatures drop to 6.5 to 5.0°C (Schwartz 1978).

More ridley turtles have been observed in coastal waters of New York and southern Massachusetts than anywhere else in the northeast (Lazell 1980; Morreale and Standora 1992). They are the turtles observed most frequently cold-stunned along the north and east shores of Long Island (Morreale *et al.* 1992). In the winters of 1985 through 1987, 97 cold-stunned ridley turtles were collected along the shores of Long Island; only 15 of these animals were alive at the time of collection.

3.4.3 Food and Feeding Behaviors

Following a pelagic feeding stage shortly after hatching and lasting for several months (Carr 1986a), juvenile ridleys move into shallow coastal waters to feed and grow. The young juveniles often forage in water less than one meter deep (Ogren 1989), but they tend to move into deeper water as they grow. In New York waters, nearly all feeding takes place on or near the bottom in shallow water (Morreale and Standora 1992, 1993). The deepest recorded dive of a juvenile ridley was to 21 m; dives usually level off at about 15 m if the bottom isn't reached (Morreale and Standora 1993).

In coastal waters of New York, young ridleys consume several species of crabs, including in order of decreasing preference, spider crabs (*Libinia emarginata*), lady crabs (*Ovalipes ocellatus*), and rock crabs (*Cancer irroratus*) (Morreale and Standora 1992, 1993). Crustaceans represent more than 80% of the diet of juvenile ridleys in the New York Bight (Burke *et al.* 1994). Other food items found in ridley stomachs include molluscs and algae. The preference for spider crabs over lady crabs, despite the fact that the latter is more abundant in ridley foraging habitat, is probably due to the greater ease of capture of the slower moving spider crabs by the small turtles (Morreale and Standora 1993).

In Chesapeake Bay, sub-adult ridleys concentrate in seagrass (*Zostera* and *Rupia*) beds and feed primarily on blue crabs (*Callinectes sapidus*) and cancer crabs (*Cancer* spp.) (Lutcavage 1981; Byles 1989). Juvenile to adult ridleys stranded on Texas beaches contained a wide variety of foods in their digestive tracts; crabs were most abundant, followed by molluscs and small fish (Shaver 1991). More than 60% of the turtles contained some plant materials in their stomachs, but it represented less than one percent of the total gut contents.

Juvenile and sub-adult ridleys in Florida and Georgia were observed to feed on the crabs *Ovalipes ocellatus* and *Heppatus ephiliticus* (De Sola and Abrams 1933; Carr 1952). Blue crabs (*Callinectes sapidus*) are the favorite food of sub-adult ridleys in Virginia (Hardy 1962; Musick 1979). Because of their preference for crabs and other primarily shallow-water demersal prey, juvenile and adult ridley turtles concentrate in coastal waters less than 100 m deep throughout their range (Thompson 1988). Blue crabs are rarely observed in deep ocean waters (NOAA, pers. comm. 1996a), therefore, it is unlikely that ridley turtles feed on blue crabs in the current MDS or within the borders of the proposed HARS.

Ridley turtles make long dives to the bottom and may feed on the bottom for an hour or more at a time; one turtle was observed burrowing in the bottom of Long Island Sound (NMFS 1988). During daylight hours, they spend most of their time under water. In a typical dive the turtle spends about 56% of its time in the upper third of the water column, 12% in the middle, and 32% of its time on the bottom (Morreale and Standora 1993). In water deeper than about 15 m, the turtles usually dive to a depth of 6 to 10 m where they appear to be swimming in a directed manner.

In New York waters, ridley turtles spend most of their time feeding in shallow water and growing rapidly. Individuals 20 to 30 cm long grow at an average rate of 2.2 cm/year; larger 30 to 40 cm individuals grow at a rate of 4.5 cm/year. These rates are slower than those for ridleys in Texas (McVey and Wibbles 1984), possibly because New York ridleys are able to occupy optimal foraging areas for only a few months each year. A growth model proposed by Márquez (1972) indicates that ridleys may reach a length of 40 cm after about four years and reach sexual maturity at a carapace length of about 60 cm after about six or seven years.

3.4.4 Known Mortality Factors

Several stages in the life cycle of Kemp's ridley turtles are sensitive to natural and anthropogenic disturbance. Each year between November and January when ocean water temperatures are falling, small numbers of ridley turtles become stranded and die on beaches of the north and east shores of Long Island and inner Cape Cod, due to cold stunning (NOAA 1991; Morreale and Standora 1992). When the water temperature drops below about 12°C, the metabolic rate of these cold-blooded reptiles decreases to the point where they are unable to swim and digest food; they become comatose and may die if not warmed quickly. A total of 115 ridley turtles stranded on Cape Cod beaches between 1977 and 1987 (Danton and Prescott 1988). In the winter of 1985/1986, 52 turtles (41 ridleys, nine loggerheads, and two green turtles) stranded in Long Island Sound (Meylan and Sadove 1986). Nine of the ridleys and 1 each of the loggerheads and green turtles survived following gradual warming at a rehabilitation center. Similar cold strandings have occurred as far south as the Indian River Lagoon, FL (Wilcox 1986).

A major cause of sea turtle mortality attributable to man is entanglement in fishing gear, particularly shrimp nets (NRC 1990). Henwood and Stuntz (1987) estimated an annual incidental capture of approximately 47,000 sea turtles of all species, with an estimated mortality of about 11,000 in the shrimp fisheries of the Gulf of Mexico and Atlantic coastal waters from Florida to North Carolina. These estimates are thought to be low (NRC 1990). Of all the turtles killed each year by U.S. commercial shrimping, 500 to 5,000 are juvenile and adult Kemp's ridley turtles. Most of the mortalities attributable to entanglement in shrimp nets are in the Gulf of Mexico. With regard to potential entanglement impacts from operation of the HARS in the New York Bight, there is no expected danger to ridley turtles from placement of Material for Remediation. Project placement buoys are expected to be taut-line mooring configurations which are readily detected and avoided by ridley turtles.

Other fishing-related deaths, caused by entanglement in lobster gear (O'Hara *et al.* 1986) and pound nets (Morreale and Standora 1989), may result in an additional 50 to 500 deaths of Kemp's ridley turtles each year. Ridley turtles, being benthic feeders, tend to become entangled in debris, including abandoned fish and crab traps, on the bottom. This incidental catch could represent as much as 7.5% of the hatchling ridleys produced each year, assuming that the 800 nests produced a total of 80,000 hatchling ridley turtles each year. This extra mortality undoubtedly is contributing to the rapid decline in the population of Kemp's ridley turtles.

Large numbers of sea turtles, including some Kemp's ridley turtles, die from eating or becoming entangled in plastic debris (O'Hara 1989; NRC 1990). Sea turtles are particularly prone to becoming entangled in monofilament fishing line and phantom fishing nets (Balazs 1985). Plastic bags and plastic particles are the most common forms ingested; they probably are mistaken for food.

Under some circumstances, chemical pollution may be a threat to ridley turtles. As part of the Sea Turtle Head Start Program, 12,422 one-year-old ridley turtles were tagged and released between 1979 and 1987 (Manzella *et al.* 1988). In 1982, 1,325 ridleys were released 6 to 10 km off the Texas coast in floating patches of *Sargassum* weed. More than 28% of the turtles washed ashore within 14 days of release, and most were coated with oil or had ingested tar balls, probably associated with the *Sargassum*. Because early pelagic stage ridleys are thought to congregate and feed in rafts of *Sargassum*, they may be vulnerable, as juvenile loggerhead turtles are (Carr 1987), to floating oil and nondegradable debris that tends to collect in driftlines of *Sargassum*. Ridleys feeding in *Sargassum* rafts or on benthic prey may accumulate metal and organic contaminants from their prey.

Ridley turtles that were cold-stunned on eastern Long Island between 1980 and 1989 contained means of 218 to 738 μg/kg wet wt (parts per billion) total PCBs, 156 to 300 μg/kg total DDT, and 27.5 to 86 μg/kg *trans*-nanochlor in their livers (Lake *et al.* 1994); concentrations were much higher in body fat. There was a general trend for mean concentrations of these organochlorines in the turtle tissues to decrease between 1980 and 1989. The concentrations of these compounds in ridleys from Long Island were higher than those found in ridley and loggerhead turtles from southern Chesapeake Bay (Rybitski *et al.* 1995) and were higher than concentrations known to cause reproductive effects in snapping turtles. Closely related Olive ridley turtles (*Lepidochelys olivacea*) collected from coastal Ecuador contained elevated concentrations of copper, lead, and zinc in their bones (Witkowski and Frazier 1982). Thus, coastal pollution may be a source of pathology in ridley turtles.

4.0 PROPOSED ACTION AND ALTERNATIVES

4.1 Background on the HARS and Proposed Action

In February 1995, EPA Region 2 (1995b) issued a Public Announcement stating that the Agency would commence a study of a 23-nmi^2 area surrounding the existing MDS. The product of the study was to be a Supplemental Environmental Impact Statement (SEIS) that would evaluate the following three alternatives according to EPA's ocean dumping regulations.

1. No action (no expansion of the MDS)

2. Expansion of the MDS for Category I material

3. Expansion of the MDS for Category I and II material

Each of these alternatives, particularly Alternatives 2 and 3, were also to be evaluated relative to impacts from historical disposal and the potential for remediating or restoring impacted benthic areas.

Development of the SEIS was started while several major Bight Apex field studies were still in progress. In May 1995, EPA announced toxicity test results[3] from benthic samples collected in the 23-nmi^2 Study Area (EPA Region 2 1995c). These data showed that if the Study Area sediment samples had come from a proposed dredging site, sediments in some parts of the Study Area would have been classified as Category III and determined to be unacceptable for ocean disposal. Bathymetric and side-scan data collected at this time also showed evidence of dredged material mounds northwest of the 23-nmi^2 Study Area (Subarea 1). In response to this new information, EPA expanded the Study Area by adding an approximately 7-nmi^2 rectangle (Subarea 2) northwest of and abutting the western border of Subarea 1. The resulting 30-nmi^2 (103.2 km^2) Study Area encompassed all benthic areas that showed evidence of dredged material disposal in the New York Bight Apex.

Other studies—some not directed at evaluating dredged material impacts—further characterized the physical, chemical, and biotic conditions of the Study Area and Bight Apex.

- Chemical analysis of infaunal (worm) tissue from the Study Area confirmed that some sediment contaminants are being bioaccumulated in the lower trophic levels.

- The hepatic tissue (tomalley) of Bight Apex lobsters was found to have levels of PCBs and 2,3,7,8-TCDD (dioxin) above currently acceptable action levels and guidelines.

- Several shipwrecks were located in the Apex and Study Area, triggering a need for a National Historic Preservation Act (NHPA) evaluation and an evaluation of the spatially-limited reef habitat created by the wrecks.

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[3]The toxicity tests reported by EPA Region 2 (1995b) were from 10-day amphipod bioassays using *Ampelisca abdita*. Study Area sediments and reference area sediments were tested side-by-side under identical conditions [refer to EPA/USACE (1991) and USACE NYD/EPA Region 2 (1992) for further description of test procedures].

The assembly of this new information generated heightened concern about the environmental consequences of historical ocean disposal in the Bight Apex, including the continued disposal of Category II dredged material. This in turn brought into question the appropriateness of continued use or expansion of the MDS. The concerns led to Federal actions detailed in a July 24, 1996 letter to several New Jersey Congressmen, signed by EPA Administrator Carol Browner, Secretary of Transportation Federico F. Peña, and Secretary of the Army Togo D. West, Jr. (July 24, 1996, 3-Party Letter):

> "... Accordingly, the Environmental Protection Agency (EPA) will immediately begin the administrative process for closure of the MDS by September 1, 1997. The proposed closure shall be finalized no later than that date. Post-closure use of the site would be limited, consistent with management standards in 40 C.F.R. Section 228.11(c). Simultaneous with closure of the MDS, the site and surrounding areas that have been used historically as disposal sites for contaminated material will be redesignated under 40 C.F.R. Section 228 as the Historic Area Remediation Site. This designation will include a proposal that the site be managed to reduce impacts at the site to acceptable levels (in accordance with 40 C.F.R. Section 228.11(c)). The Historic Area Remediation Site will be remediated with uncontaminated dredged material (i.e. dredged material that meets current Category I standards and will not cause significant undesirable effects including through bioaccumulation)..." (July 24, 1996, EPA/DOT/USACE 1996)

The July 24, 1996, 3-Party Letter further states that "The designation of the Historic Area Remediation Site will assure long-term use of category 1 dredge material," and that the three agencies will work to develop a sound dredged material management plan for the Port, reduce the backlog of dredging projects, and start a feasibility study for a 50-foot deep port.

Subsequent to the July 24, 1996, 3-Party Letter (EPA/DOT/USACE 1996), EPA Region 2 (1996) issued a Public Announcement in September 1996 modifying the scope of the SEIS from evaluating the potential expansion of the Mud Dump Site to evaluating the designation of a Historic Area Remediation Site (HARS). In the same announcement, the Agency stated that it was beginning the administrative process to close (de-designate) the MDS.

Following the 3-Party Letter and the September 1996 public announcement, EPA modified the alternatives as follows:

SEIS Alternative 1 (BA Alternative 1): No Action

- No change to size or management of the present Mud Dump Site (MDS)
- No remediation of areas outside of the MDS with toxicity or sediments degraded by bioaccumulative contaminants and sediment toxicity, or restoration of fine-grain sediment areas
- Disposal of Category I dredged material continues per the MDS Site Management and Monitoring Plan (SMMP) (EPA Region 2/ USACE NYD 1997) until current remaining disposal capacity is reached
- Category II dredged material capacity will be reached by September 1, 1997

SEIS Alternative 2 (BA Alternative 2): Close MDS-No HARS Designation

- Closure of the present Mud Dump Site
- No Historic Area Remediation Site (HARS) designated
- No remediation of sediments outside of the MDS with toxicity or sediments degraded by bioaccumulative contaminants and sediment toxicity, or restoration of fine-grain sediment areas created by past dredged material disposal

SEIS Alternative 3 (BA Proposed Action): HARS Remediation

- Simultaneous closure of the MDS and designation of 15.7-nmi^2 (54-km^2) HARS
- The HARS is composed of the Priority Remediation Area (PRA), a Buffer Zone (BZ), and No Discharge Zone (NDZ), including the MDS and sediments that have bioaccumulative contaminants and sediment toxicity. (Refer to: EPA Region 2 1997)
- Remediation conducted by capping degraded sediment areas with at least 1 m of Material for Remediation
- Approximately 40.6 Myd^3 required to remediate the 9.0-nmi^2 (31-km^2) PRA; actual placement volume may be larger to ensure at least a 1 m cap throughout the PRA
- Remediation work prioritized by degree of sediment degradation

SEIS Alternative 4 (BA Alternative 3): HARS Restoration

- Simultaneous closure of the MDS and designation of 15.7-nmi^2 (54-km^2) HARS
- The HARS is composed of the PRA, NDZ, and BZ, including the MDS, surrounding areas that has been historically used for disposal of dredged material and other wastes (e.g., building materials, sewage sludge, industrial wastes), and sediments degraded by bioaccumulative contaminants or sediment toxicity.
- Restoration work conducted by covering fine-grain sediment areas with at least 1 m of sandy (0-10% fines) Material for Remediation
- Approximately 46.4 Myd^3 required to restore the 10.3 nmi^2 (35.5 km^2) of fine-grained sediments in the PRA; actual placement volume may be larger to ensure at least a 1 m cap throughout the PRA
- Restoration work prioritized by degree of sediment degradation.

4.2 Description of Proposed Action — HARS Remediation

EPA's Proposed Action is to simultaneously close the MDS and redesignate the site and surrounding areas that have been used historically as disposal sites for contaminated material as the HARS (SEIS Alternative 3). The HARS will be 15.7 nmi^2 (54 km^2) and include the entire current MDS area. Within the HARS will be a 9.0-nmi^2 (31-km^2) Priority Remediation Area (PRA), a 500-m (5.7-nmi^2) Buffer Zone (BZ), and a No Discharge Zone (NDZ) of approximately 1.0 nmi^2. It is the Agency's determination that obtaining Material for Remediation from dredging projects in Port of New York and New Jersey and surrounding areas is the most environmentally beneficial and the most economically feasible alternative for remediating the 9-nmi^2 of degraded sediments within the PRA of the HARS.

Implementation of the HARS SMMP (EPA Region 2/USACE NYD 1997) will ensure that the degraded sediments will be sufficiently isolated from the biotic zone of the New York Bight, and that toxicity and the bioaccumulative contaminants of the degraded sediments are not exposed to the marine food chain. Futhermore, injury or death to turtles or whales is unlikely given that the Material for Remediation will be subjected to laboratory testing that must meet EPA ocean dumping regulations.

4.2.1 Estimate of Expected Volumes of Material for Remediation

Over the past seven years (1990 through 1996), more than 26 Myd^3 of dredged material was transported during 5,802 trips to the Mud Dump Site (Table 1). The annual average during this period was 3.8 Myd^3 and 829 trips, respectively, with 4,645 yd^3 of dredged material discharged per trip.

The projected volume of Material for Remediation to be placed at the HARS between now and 2000 is presented in Table 2.

Table 1. Summary of Dredged Material Volumes and Trips to the Mud Dump Site from 1990 through 1996.

Year	Volume (yd^3)	Number of Trips
1990	4,718,947	1816
1991	3,754,886	1367
1992	4,481,326	1081
1993	5,532,044	664
1994	5,208,602	351
1995	2,824,299	416
1996	429,020	107
7-yr Total	26,949,124	5802
7-yr Average Trip Volume	4645 yd^3	829

Source: USACE (1996, 1997)

Table 2. Summary of 1997-2000 Potential Volume of Remediation Material from Planned Federal and Private New York-New Jersey Harbor Dredging Projects.

Year	Expected Volumes (yd^3)
1997	2,790,400
1998	4,124,000
1999	194,000
2000	518,100
4-yr Total	7,626,50

Source: Port Authority MudOne (1996)

However, the actual number of Material for Remediation placement trips to the HARS is expected to have considerable variation depending on review, approval, and budgeting of dredged projects; port economics; agency funding or remediation work at the HARS; and alternative disposal options for the Material for Remediation (including beneficial uses). Indications from the MudOne database (Port Authority of NY & NJ 1996) are that placement activities will be less than one-half the number of disposal activities from 1990 to 1996 (i.e., less than 415 trips per year).

4.3 Analysis of Impacts

4.3.1 Water Quality

Water quality impacts associated with the existence of the current MDS and the proposed designation of the HARS are limited to disposal-event impacts which are relatively infrequent and of short duration (i.e., <1 h). Placement of Material for Remediation in the HARS must comply with marine water quality criteria and meet all other applicable EPA/USACE criteria (40 CFR Part 227).

The primary water column impact of concern to threatened and endangered species addressed in this BA is turbidity (suspended solids) which potentially affect prey species of the whales and turtles. The following text summarizes impacts to the water column from a typical Material for Remediation placement event at the HARS.

The Material for Remediation is expected to be placed in the HARS from slowly moving barges. Placement from these barges would result in classic convective descent of the material under gravitational settling followed by dynamic collapse when the descending plume impacts the bottom or reaches a neutrally buoyant position in the water column. Material leaving barge doors usually drops in a consolidated mass toward the bottom (USACE 1993). However, a small fraction, usually about 3% of the total, is eroded by water turbulence and disperses in the water column. The material remaining in the water column continues to be diluted by the dynamics of the plume body for a short period (Scorer 1957; Woodward 1959; Csanady 1973; Brandsma and Divoky 1976; Tsai and Proni 1985; Ecker and Downing 1987; Kraus 1991). Once the energy imparted by the placement activity dissipates, the plume undergoes passive diffusion which is controlled primarily by the ambient oceanographic conditions (currents and turbulence). An extensive review of the time histories of plume behavior and concentration (Ecker and Downing 1987) shows that there is generally an abrupt change (reduction) in the rate of plume dilution within 10 to 30 minutes after discharge, suggesting that initial mixing is complete within 10 to 30 minutes. Dilutions after 10 minutes typically range from 1,000:1 to 100,000:1.

Direct measurement of dredged-material plume dilution rates and transport from 4,000 to 6,000 yd^3 discharges of gravel, sand, silt, and clay at the MDS consistently show rapid dispersal of the plumes during the first few minutes after release (Dragos and Lewis 1993; Dragos and Peven 1994). A small amount of fine sediment (silt and clay) remained at measurable concentrations in the water column for up to 3 hrs. These studies also found that the rapid settling of coarse material and turbulent mixing resulted in initial dilutions of the plume of 3,000:1 to 10,000:1 within 5 to 15 minutes of dumping. Plume dilution after two hours ranged from approximately 35,000:1 to 720,000:1. Total suspended solids (TSS) concentrations near the center of the plume body approached background levels in 30 to 45 minutes.

As a Remediation Material plume descends through the water column and spreads across the bottom, it will carry with it the gravel, sand, silt, and clay fractions of which it is composed, as well as any dissolved or particulate chemical contaminants associated with it. Most of the small amount of contaminants associated with this Remediation Material will remain adsorbed to sediment particles and be rapidly deposited onto the bottom at the placement site. A very small fraction of the contaminants may be adsorbed to the silt/clay particles that remain in suspension in the water column or with the aqueous (dissolved) phase. These suspended and dissolved contaminants (compliant with all applicable marine water quality criteria and EPA/USACE toxicity tests) are diluted rapidly in the water column, but may result in measurable increases in concentrations of some chemicals in the water column for a short period after a placement event. All elevated concentrations will quickly (< 1 hour) return to background levels well within the 4-h initial mixing period specified in the ocean dumping regulations. Thus, elevated contaminant levels in the water column are localized, of short duration, and would have no effect on protected turtles or whales.

Temporary increases in water-column turbidity resulting from remediation work has low potential to affect protected species that may visit the HARS. The results of a recent hydrographic survey in the vicinity of the MDS (Dragos and Peven 1994), which represent water column conditions during active dumping at the existing MDS, indicate generally low turbidity throughout the water column with a small mid-depth maximum in the central portion of the HARS. This feature appears to extend from the north and west into the HARS. The increase in water column turbidity in the MDS due to dredged material disposal has been found to be slight to moderate and varied depending on large scale oceanographic features, such as the Hudson River discharge or coastal transport, which may increase natural background turbidity in the area. In summary, increases in turbidity due to placement of Material for Remediation are expected to be short-lived. The placement of the Material for Remediation in the HARS will not result in long-term or environmentally significant elevations in water column turbidity or water-column contaminants.

4.3.2 Physical Impacts

Physical impacts associated with designation of the HARS that could affect endangered whales and turtles include vessel traffic, changes in the sediment grain-size and bottom contour, decreased water depth and clarity, and settling of Material for Remediation particles through the water column. Each of these is discussed separately in the text that follows.

Vessel Strikes. Vessel strikes are a significant source of mortality for inshore species of baleen whales (Kenney and Kraus 1993; Wiley *et al.* 1995; NMFS 1991a,b) and there is some evidence of increased incidents in recent years of vessel collisions in northeastern U.S. waters (NMFS 1991b; Wiley *et al.* 1995). As has been documented for bowhead whales (George *et al.* 1994), the size and extent of scarring on whales indicates that collisions are primarily with large vessels such as container ships, tankers, or military vessels. There are no documented cases of collisions between fin or humpback whales and loaded dredge material barges or their tugs transiting to the current MDS. These vessels are towed at low speed (2-6 knots) and are probably easily avoided by the whales. The barges themselves do not have propellers, which are the main source of injury to whales in vessel/whale encounters. Thus, compared to the barges, tug boats are more hazardous to humpback and fin whales that might be resting on the sea surface or lunge-feeding on prey near the water surface in New York Bight Apex. Although tug boats have somewhat limited maneuverability when towing a loaded barge, they generally should be able to avoid whales on or near the surface or the whales should be able to detect and avoid them. Futhermore, there has been a decrease in barge traffic over time (Refer to Table 1). As the degraded sediments in the PRA of the HARS are covered with the 1-m cap of Remediation Material, barge traffic to the site will further decrease and further reduce the potential for vessel strikes.

Placement of the Material for Remediation by the barges will occur inside the boundaries of the HARS while the barge is underway. Placement operations will increase the underwater noise signature of the barge, probably enabling whales and perhaps sea turtles to better detect and avoid the barge and tug boat.

Humpback and fin whales should be able to detect and avoid tug boats barges in tow traveling to and from the HARS because barges are towed at a relatively slow speed of two knots (vessel speed and movements are adjusted to sea conditions), and generate fairly loud underwater sounds. A typical loaded barge may generate underwater sounds at a broad-band source intensity of about 170 dB re 1 μPa @ 1 m, with maximum sound intensity below about 200 Hz (Miles *et al.* 1987). The peak acoustic sensitivity of baleen whales is thought to be in the range of 20 to 200 Hz, the frequency range of most of their vocalizations (McCauley 1994). Generally, baleen whales can detect and respond to sounds in this frequency range that have an intensity of about 120 dB re 1 μPa or more or are 10 to 20 dB re 1 μPa above the level of ambient noise (Richardson *et al.* 1991; Advanced Research Projects Agency 1995). Thus, humpback and fin whales will be able to detect the sounds of an approaching tug and barge. However, the responses of these whales to an approaching tug and barge are unpredictable and may depend on the activity of the whale at the time or its previous experience with other motor vessels. As discussed previously (see Section 3.1.4), humpback whales are relatively tolerant of boats. However, because they are more habituated to vessel approach than any other cetacean, they may be more susceptible to ship collisions than fin whales. Fin whales, appear to be more wary of approaching boats.

Turtles are also subject to boat-related injuries. Between 1987 and 1993, up to 17% of all stranded sea turtles on the U.S. Atlantic coast had boat-related injuries (Teas 1994a,b). Ship strikes appear to be a significant source of mortality for sea turtles, particularly in waters around Long Island, and vessel-related injuries have increased in recent years (Teas 1994a,b). Of the two species of sea turtles that are evaluated in this BA, loggerhead turtles appear to be more susceptible than Kemp's ridley turtles to collisions with boats near the HARS because they usually are larger and visit the New York Bight Apex in larger numbers.

Juvenile loggerhead and Kemp's ridley turtles visit the general area of the Bight Apex each summer to feed. Juvenile ridleys, and to a lesser extent juvenile loggerheads, rarely feed in water depths greater than 15 to 20 m. Therefore, they would not be expected to visit the areas of the HARS that will be remediated, most of which are deeper than 20 m.

While feeding, ridley and loggerhead turtles spend most of their time submerged. Sub-adult and loggerheads are primarily bottom feeders, foraging in coastal waters for benthic molluscs and crustaceans (Bjorndal 1985). During feeding, they spend more than 57 minutes of each hour submerged (Thompson 1988) and between 25 and 58% of their time on the bottom (Standora *et al.* 1994). Feeding dives last from about four minutes to as long as two hours (Renaud and Carpenter 1994). In New York Bight waters, sub-adult ridley turtles probably feed primarily on benthic crustaceans. They make long dives to the bottom and may feed there for an hour or more at a time (NMFS 1988). During their long periods of submergence, loggerhead and ridley turtles are not very vulnerable to collisions with barges. Given the underwater feeding behaviors and preference for feeding in shallow water, the potential for collisions between juvenile loggerheads and ridley turtles and barges transiting between the Port of New York and New Jersey and the HARS is low.

Vessel Traffic. The Middle-Atlantic Bight supports some of the busiest commercial and military shipping lanes on the east coast of the U.S. Additionally, the Bight Apex has an increasing amount of vessel traffic independent of the HARS (e.g., fishing boats from nearby areas). Thus, the increase of visits and seasonal residency of humpback whales in the area is likely to result in an increase in potentially adverse interactions between the whales and human activities (Wiley *et al.* 1995; Sadove and Cardinale 1993; Swingle *et al.* 1993).

The transport of the Material for Remediation to the HARS will require transit through the New York Bight Apex. Although, the New York Bight Apex is not an area of high concentrations of endangered whales and turtles, there is some potential for encounters and impacts with disposal vessels. As previously presented, there will be fewer trips for placement in 1997-2000 than there were for disposal in 1990 to 1996. This vessel traffic is less than the average number of trips from 1990-1996 to the existing MDS (829 trips/yr). Because the number of trips to the HARS is expected to be less than the number of trips to the current MDS, the likelihood of illegal takes of these endangered and threatened species through direct collisions or physical or acoustic disturbance of normal social, feeding, or nursery behavior should be less.

Physical Disturbance. Numerous studies have attempted to document the effects of ships on cetaceans (Richardson *et al.* 1985; 1991). It is likely that whales react primarily to the noise generated by vessels, not to their physical presence. Similarly, the physical presence and activities of vessels and vessel traffic do not appear to be an important source of disturbance to sea turtles.

Vessels may physically displace some species from feeding areas and may interrupt courtship, breeding, and other social activities if the vessel makes repeated approaches or if vessel traffic is dense. There is some evidence that cetaceans have been displaced from traditional feeding and wintering areas due to increased vessel traffic in Hawaiian waters (Baker *et al.* 1982; Forestell 1986).

Sea turtles do not appear to be disturbed by the physical presence of vessels or other human activities. They may dive when approached by a vessel and avoid areas of intensive human activities. Therefore, protected species of whales and sea turtles do not appear to be particularly sensitive to physical disturbance from vessel activities. They are unlikely to be disturbed by the physical presence in the New York Bight Apex of barges transporting or placing Remediation Material.

The Material for Remediation will likely be released through doors in the bottom of the barge while the barges are underway. During placement activities, a dense plume made up of particles, some in large clumps, entrains ambient sea water as it falls rapidly to the sea floor. The turbidity and turbulence in the descending plume from the Material for Remediation is high at first, but decreases rapidly. There is some chance that sea turtles foraging near or on the bottom in the area could be engulfed by the descending Material for Remediation and sustain injury or death. The potential magnitude depends mainly on the frequency with which juvenile loggerhead and ridley turtles forage within the boundaries of the HARS and the extent to which they can detect and avoid the barges and the descending Material for Remediation that will be placed within the HARS.

Conditions of water depth and availability of preferred foods are not optimal within the HARS and sea turtles are not known to forage there. Sea turtles can detect underwater sounds of the intensities and frequencies produced by underway tugs and barges, but often do not respond to such noises, unless they are intense. Therefore, even if turtles are feeding within the site, they probably would not be deterred by the presence of the barges. Impacts of the descending Material for Remediation on foraging sea turtles probably will not be severe. Both ridleys and loggerheads are known to dig in and bury themselves in bottom sediments. If turtles become buried by descending Material for Remediation, they probably will escape from all but the thickest portions of the placed material. Turtle encounters with plumes from the Material for Remediation in the water column probably will disturb the animals but will not be injurious.

In summary, the potential for harm to protected sea turtles from the placement of Material for Remediation at the HARS is low.

There is even less potential for whales to be impacted by falling Material for Remediation during placement activities. Fin and humpback whales have never been reported within the boundaries of the HARS, but have been spotted in the general area and could move through the site on occasion. They can detect the presence of the moving barge and tug traffic. Moreover, the species can likely detect the placement of Material for Remediation events. Because they are fast swimmers and water depth is shallow within the HARS, it is highly likely that, if present in the HARS during a placement of the Material for Remediation, they would avoid the barge and not remain under it. Swimming through a plume would not harm a large animal like a whale because they do not breathe water and are sensitive to natural suspended sediments.

Acoustic Disturbance. Low-frequency sounds, such as those produced by underway motor vessels travel for long distances under water. These sounds, if they are intense enough, may cause injury to the ears of whales and turtles, or even death from concussion. Lower intensity sounds in the frequency ranges heard and used for communication by these animals may interfere with normal intraspecies communication, detection (by echo-location) of prey, and orientation (Richardson *et al.* 1991).

Motor vessels add noise to an already noisy underwater marine environment. The total background ambient noise in the open ocean is about 74 to 100 dB re 1 μPa (Table 3). However, several natural sound sources, such as earthquakes, lightning strikes, and some biological noises, such as vocalizations of baleen whales and some swimbladder sounds of fish, may temporarily increase natural ambient noise above these levels.

In comparison to total background ambient noise presented in Table 3, vessel noises, caused by the turning of the screws, engine noises, and noises of operating machinery on board, generally fall in the range of 5 to 2000 Hz, with highest intensities below 100 Hz (Scrimger and Hietmeyer 1991). Sound intensity, particularly at higher frequencies, tends to increase with the size of the vessel. Supertankers and large container ships may have a maximum broad-band sound source level of 190 to 200 dB re 1 μPa at 1m (Table 4). Small outboard motor vessels produce broad-band sounds of about 150 dB re 1 μPa at 1 m; these sounds are attenuated to the range of 85 to 140 dB re 1 μPa at a distance of 50 m from the source (Richardson *et al.* 1991). Peak source sound pressures for tug boats towing barges are in the range of 160 to 170 dB re 1 μPa at 1 m (Buck and Chalfant 1972; Miles *et al.* 1987; Malme *et al.* 1989).

Most marine animals can perceive underwater sounds over a broad range of frequencies from about 10 Hz to more than 10,000 Hz. Peak acoustic sensitivity of sea turtles, and baleen whales is below about 1,000 Hz and generally in the range of 20 to 200 Hz (McCauley 1994).

Baleen whales produce a wide variety of sounds, some of them of considerable intensity. They are thought to use sound for intraspecific communication and possibly also for echolocation and to aid in prey capture. Sounds often are frequency-modulated and range from short chirps and clicks to complex songs. Most baleen whale sounds fall in the frequency range of 12 to about 1,000 Hz, with some sounds as high as 8,000 Hz (Richardson *et al.* 1991; McCauley 1994). The high-frequency clicks (up to 31 kHz) sometimes recorded in the vicinity of fin, blue, minke, and gray whales have not been attributed with certainty to the whales themselves. If produced by the whales, they could be used for echolocation, as high frequency sound is by toothed cetaceans. The low-frequency moans, grunts, rumbles, and pulsive sounds produced by many baleen whales are in the frequency range of highest intensity sounds produced by motor vessels,

Table 3. Maximum Broad-Band (20-1000 Hz) Sound Pressure Source Levels for Different Types of Natural Ambient Noise in the Marine Environment.

Noise Source	Maximum Source Level (dB re 1 μPa @ 1 m)	Remarks
Undersea Earthquake	272	Magnitude 4.0 on Richter scale (energy integrated over 50-Hz band width)
Seafloor Volcanic Eruption	255+	Massive steam explosions
Lightning Strike on Water Surface	250	Random events during storm at sea
Baleen Whales	to 188	<2000 Hz simple and complex calls, clicks, pulses, knocks, grunts, moans
Swimbladder Sounds of Fish	~140	Marked spectral peaks in 50-3000 Hz range
Dugong	<90	2000-5000 Hz simple chirps and squeaks
Total Open-Ocean Ambient Noise	74-100	Estimate for offshore central California, sea state 3-5; expected to be higher (≥120 dB) when vessels are present
Rain Storm	80	Heavy rain shower, flat frequency spectrum
Wind	66	Force 3 wind over water

Sources: Richardson *et al.* (1991), McCauley (1994), and Advanced Research Projects Agency (1995).

particularly large vessels, such as tankers and container ships (Table 4). Low-frequency vocalizations in the 10 to 40 Hz range may be used by baleen whales for long-range communication (Payne and Webb 1971). Humpback whales (Thompson *et al.* 1986) and fin whales (Edds 1988) all produce low frequency moans, tonal, pulsive and grunting sounds in the 10 to 40 Hz range. These low frequency sound travel great distances with little attenuation in ocean waters, making them ideal for long-distance communication. The loud, low frequency sounds produced by motor vessels may interfere with this long-range communication.

Most baleen whales respond to constant, low-frequency sounds with broad-band intensities of more than about 120 dB re 1 μPa (Advanced Research Projects Agency 1995). However, actual thresholds for behavioral responses to sounds in the natural environment depend on the level of natural ambient noise. Whales apparently are able to distinguish sounds in their optimum frequency range that are 10 to 20 dB re 1 μPa above ambient noise at the same frequency (Richardson *et al.* 1991). The threshold intensity of constant or impulsive sounds for injury to the hearing apparatus of marine mammals and turtles is about 200 to 220 dB re 1 μPa (Greenlaw 1987; McCauley 1994).

Table 4. **Estimated Peak ⅓-Octave Sound Pressure Source Levels for Vessels of Different Sizes and Speeds.**

Vessel	Speed (knots)	Sound Pressure Level (dB re 1 μPa @ 1 m)	Reference
>250-m Large Oil Tanker	16	203	Cybulski 1977
274-m Container Ship (23 Hz)	--	198	Richardson *et al.* 1991
340-m Supertanker	20	190	Buck and Chalfant 1972
WWII Battleship	20	183	Urick 1983
337-m Tanker (20 Hz)	16	177	Cybulski 1977
Icebreaker	10	174	Malme *et al.* 1989
135-m Freighter	--	172	Richardson *et al.* 1991
Large Ferry	16	171	Malme *et al.* 1989
Tug and Loaded Barge	--	170	Miles *et al.* 1987
210-m Container Ship	19	169	Jennette *et al.* 1987
Cruise Ship	19	168	Malme *et al.* 1989
20-m Tug and Empty Barge	--	166	Buck and Chalfant 1972
200-m Roll On/Off	15	165	Jennette *et al.* 1987
190-m Car Carrier	16	162	Jennette *et al.* 1987
Tug and Barge	10	162	Malme *et al.* 1989
34-m Twin-Diesel Tour Boat	10	159	Malme *et al.* 1989
Fishing Trawler (transit)	10	158	Malme *et al.* 1989
Fishing Trawler (trawling)	5	147	Malme *et al.* 1989
16-m Crew Boat	--	156	Greene 1985
7-m Boat with 2 x 80-hp outdrive	20	156	Malme *et al.* 1982
8-m Boat with 260-hp outdrive	10	156	Malme *et al.* 1982
4-m Boston Whaler/20-hp outboard	20	153	Malme *et al.* 1982
5-m Zodiac with 20-hp outboard	20	152	Malme *et al.* 1982
4-m Boat with 25-hp outboard	20	152	Malme *et al.* 1982
20-m Tour Boat	10	150	Malme *et al.* 1989
Small Boat with 18-hp outboard	5	150	Evans 1982

There are conflicting reports of the short-term effects of vessel engine noise on marine mammals (*i.e.*, some species of whales react to noise at great distances, some do not). There is some limited evidence that abrupt changes in vessel RPMs may disturb whales (Watkins 1986); however, it appears that they readily acclimate to the noise in their environment. Overall, reactions to human-generated noise vary not only between species, but also within species (Richardson *et al.* 1991). Some studies indicate that whales may react to short-term acoustic disturbances by moving away from the sound source, changing breathing and diving patterns, or through possible agonistic displays (NMFS 1991b). Reactions have been documented as far as 4 km from the vessel (Ljungblad *et al.* 1988; MMS 1992). Studies off the California and Alaska coastlines have shown that most species of cetaceans adjust to the presence of offshore drilling equipment (Geraci and St. Aubin 1987). However, studies of bowhead whales in the Arctic indicate that individuals will often change course and behavior when exposed to the intense noise generated by active rigs and seismic vessels (Ljungblad *et al.* 1988; Richardson *et al.* 1985; 1991). Bowhead whales in the Beaufort Sea react, at least briefly, to aircraft, ships, seismic exploration, marine construction, and offshore drill sites (Richardson and Malme 1993). To date, there is no conclusive evidence that this short-term disturbance leads to long-term effects on individuals or populations (Richardson *et al.* 1991).

Sounds produced by tug boats towing barges with or without a cargo probably produce underwater sounds with peak intensities in the frequency range of whale audition of about 165 dB re 1 μPa. These sounds attenuate naturally in the water to about 120 dB re 1 μPa at about 2 nmi from the source. These vessel sounds are clearly audible to any humpback and fin whales in the vicinity of the HARS at the time. However, these sounds are much too weak to cause outright harm to the whales. It is doubtful that such sounds will cause lasting behavioral alterations to the endangered species (Richardson *et al.* 1991).

The sensitivity of sea turtles to acoustic disturbance has not been well studied. Turtles may use acoustic signals within their environment for orientation to natal beaches (Lenhardt *et al.* 1983). In addition, loggerhead turtles swam towards the surface when exposed to low-frequency, high-intensity sounds (20-80 Hz, 175-180 dB) while underwater (Lenhardt 1994). This could expose turtles to collisions with boats. However, typical vessel sounds do not seem to disturb sea turtles. Therefore, the noise added to the marine environment by the barges and tug boats carrying the Material for Remediation is unlikely to affect sea turtles.

Summary of Vessel Impacts. Trips to the current MDS over the past 6 years have not resulted in any illegal takes of fin or humpback whales or loggerhead or Kemp's ridley turtles (USACE, pers. comm. 1996). It is not anticipated that this situation will change with designation of the HARS.

Changes to the Contour of the Bottom. The disposal mounds in the current MDS have very little slope (e.g., 0.3°), and the steepest mounds have a slope of 1° to 3°. There will be no substantial changes to the large scale mounds or other large features on the bottom in areas of the HARS.

Grain Size. The Remediation Material is expected to be composed primarily of fine-grain silts and clays, unless significant volumes of sandy material are excavated from new work projects (e.g., 50-Foot Deepening Project). Presently, the proposed HARS contains material of varying grain size; sand, sandy-mud, and mud. The area also contains rocks of various sizes. Some rocky and hard bottom areas could be covered in the remediation process resulting in changes to the benthic fauna. Over time, the surface sediments of the site will have more silt and clay and there will be less sand. The end result will be a mixed environment of silts and clays, with some sandy areas in the shallow (<20 m) waters.

Changing some HARS sediments from sands to silts and clays could potentially impact whale and turtle prey that inhabit rocky or sandy areas. The only whale prey that is habitat-dependent is sand lance, which is found on sandy substrates. The HARS is composed of sandy sediment in most areas. The loss of some of this habitat could negatively affect whale prey in this area. Given the wide-ranging presence of whales in the New York Bight and the presence of such habitats in areas outside the HARS, a change in sediment composition in the HARS will not jeopardize whale food sources.

Turtles feed on many species of crabs (cancer, horseshoe, blue, and spider) that are associated with muddy or sandy sediment. However, these crab species are not as habitat-dependent as sand lance. For example, cancer crabs prefer sandy substrates, but have been collected from mud and hard bottom environments. Horseshoe crabs forage for prey in sand and mud substrates. Although the preferred prey species of loggerhead and ridley turtles may be present within the HARS, the turtles are unlikely to forage there because water depths exceed their preferred foraging depth. In summary, it is unlikely that sediment changes within the HARS will adversely affect the turtles.

4.3.3 Biological Impacts

Sea turtles and whales bioaccumulate contaminants from their ocean environment almost exclusively through their food sources. As air-breathing animals, the outer integument of these animals is much less permeable than the gills of fish or the body walls of marine invertebrates. Therefore, passive or active bioconcentration of inorganic and organic chemicals directly from solution in the water is much less important than bioaccumulation from food for entry of chemical contaminants into living turtle and whale tissues. The major mechanism by which degraded surface sediments that currently are within the HARS can harm protected species of whales and turtles is by bioaccumulation of sediment-associated chemicals through the marine food chain. Invertebrate and fish prey items living in these degraded sediments and the overlying water column at the HARS may bioaccumulate chemicals from solution or from benthic foods. The turtles and whales may in turn become potentially contaminated by consuming contaminated prey from the disposal site. However, because the whale food chain is a pelagic one, whales are unlikely to become contaminated through this route.

Sea turtles are top consumers in a largely benthic food web. However, as discussed in the SEIS (EPA Region 2 1997), present contaminant levels in the degraded sediments of the HARS do not appear to be negatively affecting either local infaunal community structure or the higher trophic-level organisms that feed directly or indirectly on the infauna within the HARS.

Both the endangered sea turtles and whales evaluated in this BA are the top consumers in short, relatively simple food webs and generally feed for only a brief time each year in the vicinity of the HARS in the New York Bight Apex. Based on our current level of understanding of bioaccumulation by sea turtles and whales, it appears to be unlikely that these species could bioaccumulate contaminants from degraded sediments or dredged material in the HARS to concentrations that would be harmful to them. A detailed evaluation of the potential for bioaccumulation of sediment-associated chemical contaminants by sea turtles and whales is included in Appendix A. Remediation within the HARS will further immobilize contaminants existing in the sediments and decrease the exposure to endangered and threatened species.

The Food Web of Endangered Whales and Turtle Species. As discussed above, there is a very limited potential for fin and humpback whales to bioaccumulate chemical contaminants from degraded sediments, because the whales depend on a pelagic food web that is not linked to the benthic environment. The limited potential that exists currently for contaminant bioaccumulation from degraded sediments by whales will be reduced following remediation of the degraded areas.

Fin whales eat many of the same foods as humpback whales and the two species frequently are seen feeding together in spring/summer feeding areas (CeTAP 1982). Humpback and fin whales feed opportunistically in the New York Bight on a variety of small schooling fishes (sand lance, herring, and mackerel) and planktonic crustaceans (mainly euphausiids) (Mitchell 1975; Overholtz and Nicolas 1979; Payne *et al.* 1979). These prey species are all zooplankton feeders or, in the case of mackerel, they feed on small fish that feed on zooplankton. Thus, fin and humpback whales are the top consumers in a relatively shore pelagic food chain composed of primary producers (phytoplankton), primary consumers (zooplankton), small carnivores (zooplankton-eating fish and euphausiids), and whales. Chemical contaminants associated with sediments are unlikely to enter this pelagic food chain leading to endangered whales. In addition, the short food chain means that chemicals with a tendency to biomagnify in marine food webs will biomagnify to a lesser extent in the whale food chain than in a longer food chain.

Loggerhead and ridley sea turtles are bottom feeders, foraging in coastal waters for benthic molluscs and crustaceans (Bjorndal 1985). They appear to be particularly fond of cancer crabs (*Cancer* spp.) and blue crabs (*Callinectes sapidus*). The benthic crabs are primarily scavengers, feeding on dead and decaying plants and animals. The benthic molluscs are primarily filter feeders, feeding on phytoplankton or small infaunal organisms. Thus, the food chain leading to the protected sea turtles also is relatively short. The turtles, if they fed for extended periods of time on contaminated crabs, could bioaccumulate dioxins, dibenzofurans, and other highly hydrophobic chemicals to high concentrations presently within degraded sediment areas of the HARS. However, this potential for impact is very low because both loggerhead and Kemp's ridley turtles forage at shallower water depths than occur at the HARS, and so are unlikely to feed on benthic crustaceans and bivalves from the site. Like with the whales, the small potential for contaminant bioaccumulation by turtles that might forage in the degraded sediments areas of the HARS will be further reduced by placement of a 1-m cap of Remediation Material.

Bioaccumulation and Trophic Transfer of Contaminants. As discussed earlier, the HARS will receive at least 1 m of Remediation Material, which will decrease the level of contamination in surficial sediments in the area that could bioaccumulate in marine organisms to concentrations that could be harmful to the organisms themselves or their consumers. Therefore, benthic and demersal marine animals living in the HARS and presently bioaccumulating contaminants from degraded sediments, will have less bioaccumulation potential after the site is remediated.

Benthic crustaceans collected in the past from the vicinity of the existing MDS contained elevated concentrations of polychlorinated dibenzodioxins and dibenzofurans (Rappe *et al.* 1991), possibly derived in part from historical placement of dredged material in the New York Bight. Placement of the Material for Remediation at the HARS will bury and isolate these contaminants and decrease the bioaccumulation potential by benthic and demersal marine animals that might be in the food chains of protected marine turtles and whales. Potential contaminants sources such as the Hudson River plume and atmospheric deposition will not be affected by the Proposed Action. [However, it should be noted that additional actions (e.g., Comprehensive Conservation and Management Plan for Hudson Estuary) are being implemented by EPA and other agencies to reduce the exposure potential of contaminants (e.g., polychlorinated dibenzodioxins and dibenzofurans, methyl mercury, PCBs, and chlorinated pesticides) in the New York Bight Apex].

Large baleen whales, such as fin and humpback whales, consume food equivalent to about 4% of their body weight each day during the feeding season (Brodie *et al.* 1978; Lockyer *et al.* 1985). Only a small fraction (usually a few percent) of the contaminants associated with food is absorbed across the gut and is assimilated into the tissues of the whales. Therefore, the whales would have to feed heavily on contaminated prey from the New York Bight Apex for an extended period of time to bioaccumulate contaminants to high concentrations, assuming that prey from the Apex is more contaminated than prey from other parts of their seasonal foraging range. Actually, fin and humpback whales depend on a pelagic food web that is not tightly linked to the benthic environment. This pelagic food web is, at most, minimally affected by bioaccumulation of chemical contaminants from degraded sediments and dredged material in the New York Bight Apex. Therefore, contaminated sediments are not a quantitatively important source of tissue contamination of fin and humpback whales that visit the New York Bight for a short time each year to feed on pelagic prey.

Concentrations (0.1 to 1.9 µg/g wet weight) of total polychlorinated biphenyls (PCBs) in blubber of right whales from the Bay of Fundy and on Browns-Bacaro Banks, Canada, were much lower than concentrations in tissues of toothed cetaceans (Woodley *et al.* 1991). Sei whales, which also are zooplankton feeders, from Iceland also contained low concentrations of PCBs (Aguilar and Borrell 1991). The predominantly piscivorous baleen whales, fin and humpback whales, on average, contained higher concentrations of total PCBs in their blubber than the right and sei whales (Taruski *et al.* 1975; Aguilar and Borrell 1991) but less than the right and sei whales. Eight humpback whales from the northwest Atlantic population, reported by Geraci (1989), contained 4.4 to 32.1 µg/g wet wt. total PCBs in their blubber. These concentrations are higher than those reported by others for humpback and fin whales from other North Atlantic populations, but are lower than concentrations in the tissues of toothed cetaceans, such as bottlenose dolphins (Geraci 1989) and beluga whales (Martineau *et al.* 1987). Although concentrations of organochlorines in blubber of humpback and fin whales from the western North Atlantic Ocean are elevated, there is no evidence that the tissue residues are harming the whales or that the whales accumulated the contaminants from food ingested during visits to the New York Bight Apex.

Concentrations of total and organic mercury in tissues of baleen whales generally are low, certainly much lower than those in tissues of toothed whales (Sanpera *et al.* 1993; O'Shea and Bronwell 1994). Livers of fin whales from waters off Iceland and Spain generally contain less than 2.0 mg/kg dry wt total mercury, less than 50% of which is organic. Muscle and kidney tissues contain lower concentrations of total mercury, but most of it is organic. Thus, mercury contamination does not appear to be a potential problem in North Atlantic baleen whales. Benthic animals, including nemerteans, bivalve molluscs, shrimp, crabs, and polychaete worms from the New York Bight Apex, including the vicinity of the HARS, generally contain low concentrations of total mercury, usually less than 0.1 mg/kg dry wt. (Steimle *et al.* 1994). Thus, possible prey items of protected turtles and whales from the vicinity of the HARS are unlikely to contain elevated concentrations of organic mercury in their tissues that could represent a hazard through trophic transfer to protected whales and turtles that might consume them.

There is little information on levels of contamination of sea turtles with organic and metal contaminants that have the potential to biomagnify. Sea turtles, except leatherbacks, are poikilotherms and, therefore, consume food at a lower rate than homeotherms, such as whales. Therefore, a longer period of consumption of contaminated food would be required to effect

Peak Period of Abundance

Humpback whales – December to January
Fin whales – January to March
Loggerhead turtles – July to August
Kemp's ridley turtles – July to August

significant biomagnification. Mean concentrations of total PCBs in liver of Kemp's ridley turtles from the shores of eastern Long Island decreased from 0.66 μg/g wet wt in 1980 to 0.27 μg/kg in 1989 (Lake *et al.* 1994). Mean concentrations in subcutaneous fat decreased from 1.25 μg/kg in 1985 to 0.48 μg/kg in 1989. By comparison, PCB concentrations in livers of loggerhead and ridley turtles collected in 1991 and 1992 from coastal waters of Virginia and North Carolina were 0.007 μg/kg to 0.61 μg/kg (Rybitski *et al.* 1995). Subcutaneous fat of the same turtles contained 0.06 μg/kg to 1.73 μg/kg total PCBs. Loggerheads contained higher concentrations of PCBs than ridleys. Some of the turtles sampled in Virginia and North Carolina may have foraged during the summer in coastal waters of the New York Bight. These concentrations of PCBs are relatively low for tissues of a coastal marine animal and indicate a declining temporal trend in organochlorine contamination of these turtles. Placement of at least a 1-m cap of Remediation Material at the HARS will decrease the total environmental load of bioavailable organochlorine compounds to the Bight by permanently isolating the contaminants.

Therefore, considering that:

- The Material for Remediation is "uncontaminated dredged material (i.e., dredged material that meets current Category I standards and will not cause significant undesirable effects including through bioaccumulation) (July 24, 1996, EPA/DOT/USACE 1996);
- Any potential prey items or food chain organisms in the HARS leading to protected whales and sea turtles should be less contaminated after remediation of degraded sediments in the HARS;
- The limited potential that exists currently for contaminant bioaccumulation from sediments in the HARS by whales will be reduced following remediation of the degraded areas;
- Whales and sea turtles would need to consume a large amount of contaminated prey over an extended period of time to exhibit contaminant biomagnification;
- The water depth at the HARS is deeper than the preferred foraging depth for both species of protected sea turtles;
- Although both humpback and fin whales are present in the general area of the New York Bight in all months of the year, the limited availability of prey in the HARS makes it unlikely that they will forage exclusively or for extended periods of time in the area, before or after degraded sediment remediation;
- Seasonal temperature changes restrict the distribution of loggerhead and ridley turtles to a few months each year during the summer;
- No reported mortalities due to barges and tugs for activities conducted at the current MDS;
- Whales can detect barge/tug presence, and because of the slow speed at which barges and tugs operate, whales can avoid them; and
- Management actions (i.e., disposal inspector/certified NMFS observer) will mitigate potentially adverse impacts to turtles and whales during placement of the Material for Remediation activities,

it is likely that protected species of whales and sea turtles will have less potential to bioaccumulate contaminants and will be subject to less impacts under the Proposed Action, compared to the other alternatives. Further, by providing for remediation of the areas of the HARS by placement of Material for Remediation, the Proposed Action should actually improve environmental conditions and thus be beneficial to endangered and threatened species.

4.3.4 Cumulative Impacts

Chemical Contaminants. The cumulative impacts to endangered species resulting from chemical contamination of the New York Bight Apex marine environment can be evaluated by investigating all sources of contaminants to the inner Bight. Currently, the three major sources of contaminant inputs to the

Bight Apex (and the greater New York Bight) are dredged material disposal at the MDS, outflow from the Hudson River (across the Sandy Hook - Rockaway Point Transect), and atmospheric inputs (HydroQual 1989a). Point-source effluents and nonpoint-source runoff from the shores of New York and New Jersey bordering the Bight also contribute to contaminant loads in the New York (HydroQual 1989a). Disposal sites for cellar dirt, sewage sludge, and industrial wastes were located in the past in the New York Bight and outer continental shelf; these disposal sites have been de-designated and are no longer in operation, but may present residual sources of anthropogenic contaminants.

In USACE New York District/ EPA Region 2, only dredged material classified as Category I or Category II is acceptable for disposal at the current MDS. At the HARS, only Material for Remediation will be used for remediation. As previously discussed, the Material for Remediation is defined as ". . . uncontaminated dredged material (i.e. dredged material that meets current Category I standards and will not cause significant undesirable effects including through bioaccumulation). . ." (July 24, 1996, EPA/DOT/USACE 1996). The overall consequence of the Proposed Action is that the HARS, including the MDS, will be reduced as a potential source of chemical contamination in the New York Bight Apex environment. Degraded sediment areas found in the HARS will be covered with at least 1 m of the Material for Remediation, thereby decreasing the likelihood that contaminants from the degraded areas will vertically migrate to the biotic zone and be available for uptake into the tissues of resident benthic marine organisms (e.g., SAIC 1996).

Following completion of remediation operations in the HARS, sea turtles and whales with the remote potential to forage for bottom prey within the site will only come in contact with Material for Remediation. The layer of this material will be sufficiently thick that infaunal prey organisms will not be exposed to degraded sediments underneath. For example, sand lance bury themselves 10 to 15 cm in the sand for refuge (Bigelow and Schroeder 1953), a far shallower depth than the minimum 1-m cap of the Material for Remediation that would be placed in the HARS under the Proposed Action.

Contaminants that are transported from the New York/New Jersey Harbor across the Sandy Hook - Rockaway Point Transect (in the southern limit of the lower New York Bay) originate from numerous municipal and industrial treatment plants along the Hudson River and the innumerable nonpoint sources of contaminants in the watershed (HydroQual 1989b), which has the largest drainage basin contributing to the flow across the transect. Most of the contaminants of concern in the Hudson River plume are associated with suspended particles of natural sediment. In recent years, the levels of contaminants discharged to the Hudson River and its drainage basin have decreased as enforcement of effluent limits has become more stringent, improvements to the CSO systems have been completed, and implementation of nonpoint source controls have taken effect (Brosnan *et al.* 1995). Extensive annual monitoring of the water quality of New York Harbor has clearly demonstrated the effectiveness of these controls and the resulting improvements to water quality of the Harbor (NYC 1993; 1994). New York City reports that metals loading from its treatment facilities declined by 50 to 97% between 1985 and 1993. Moreover, application of sophisticated analytical techniques to monitor sewage effluent also resulted in substantially lower estimates of PCB loading to the Harbor (NYC 1993) from these sources. Input of total PCBs to the Harbor from water pollution control facilities (WPCF) in 1993 was calculated at 0.37 kg/d; wet weather loadings from CSOs and storm runoff added an additional 0.16 kg/d. These loadings are approximately 45% of the inputs calculated in previous Harbor Estuary Program Reports (NYC 1993). As a result, estimates of contaminant inputs to the Bight in association with the Hudson River Plume have decreased. In addition, continued reduction of emissions from industrial and energy production in the past decade have lowered atmospheric inputs to coastal waters. Thus, there has been a general decrease in contaminant inputs to the Bight Apex and the HARS since the late 1980s.

Currently, most of the nutrients entering the Bight come from the New York/New Jersey Harbor area (HydroQual 1989b). Although atmospheric inputs are significant on a Bight-wide scale, these inputs are equal to those associated with the Hudson River Plume only if the amount recycled to the water column after deposition in the sediment is added to the atmospheric input (HydroQual 1989b). Nutrient inputs to the Bight from dredged material disposal at the current MDS are extremely small relative to other sources.

Based on the information discussed above, the impact of designating the HARS will result in less contaminant loading to the Bight because degraded sediment areas will be covered. Furthermore, water quality in the Bight should continue to improve because of the institutional controls already put in place. While there is no direct evidence that historic contaminant loading in the New York Bight Apex has harmed protected whales and sea turtles that visit the area in small numbers each year, improvements in water quality in the area in recent years may have contributed to the increased frequency of visits to the area by humpback and fin whales. It is unclear if larger numbers of juvenile loggerhead and ridley turtles have visited coastal waters of the northwestern Bight to feed during recent summers.

Disturbance. Possible disturbance to protected species of whales and sea turtles from use of the HARS for placement of the Material for Remediation could come from barge traffic to and from the site. The barge traffic associated with dredge material disposal at the current MDS and the anticipated traffic at the HARS will be only a small fraction of the total vessel traffic in the New York Bight Apex and reflects a decline from past historical use of the MDS. A general indication of vessel traffic in the New York Bight Apex can be gained from statistics compiled by the U.S. Coast Guard on the numbers and types of commercial vessels that traversed the New York Bight in 1995 (USCG, pers. comm. 1996) [recreational and private boat traffic data are unavailable]. A total of more than 4,200 commercial vessels (passenger, freight, and tankers) traversed the New York Bight Apex in 1995 (Table 5). The average total length of passenger vessels was 800 ft, that of freighters and tankers was 700 ft. The number of large commercial vessels traversing the New York Bight each month ranged from 311 in February to 404 in June. Commercial vessel traffic was highest from June to September, which corresponds with peak occurrences of humpback whales and loggerhead turtles in the New York Bight Apex. It is assumed that the summer period also corresponds to peak recreational boat traffic also in the Bight Apex.

Recreational and smaller (<1,600 gross tons) commercial vessels add to the vessel traffic in the New York Bight Apex (Tables 6 and 7). A total of 212,248 recreational (e.g., pleasure boats), livery (e.g., water taxis) and commercial (e.g., fishing boats) vessels were registered in New York City in 1994 (22,429) and the state of New Jersey in 1996 (189,819); many of these vessels are assumed to traverse the Bight Apex several times each year.

The volume of traffic transiting from the Ports of New York and New Jersey to the HARS will be a small fraction of the total vessel traffic in the New York Bight Apex. The total commercial traffic in through the Bight Apex in 1995 was 4,253 vessels. Several thousand smaller commercial and recreational vessels also traversed the area. By comparison the number of trips by barges to the current MDS (assuming one trip equals one vessel) in 1995 was 416. Therefore, the current barge traffic to the MDS, and anticipated traffic to the HARS (after September 1, 1997) represents less than 10% of the total large vessel commercial traffic transiting the New York Bight Apex and probably less than 5% of the total vessel traffic in the Bight Apex. Assuming that the volume of large vessel commercial traffic remains constant, the tug/barge traffic to the HARS will represent only a small percentage of the total traffic in the area. Considering the total estimated 1996 (based on 1995) commercial traffic, plus the total number of licensed vessels in the city of New York (22,429), the 1996 tug/barge trips of 107 to the HARS is a minor percentage of the total

Table 5. Commercial Vessel Traffic into New York Harbor, 1995, by Month.

Month	Vessel Type (average gross tonnage)			Total Number of Vessels
	Passenger (50,000)	Freight (12,000)	Tanker (20,000)	
January	2	262	89	353
February	0	228	83	311
March	0	273	81	354
April	6	248	63	317
May	10	249	67	326
June	24	300	80	404
July	30	268	78	376
August	30	264	87	381
September	38	257	93	388
October	26	258	85	369
November	3	258	79	340
December	5	246	83	334
Total for 1995	174	3111	968	4253

Source: USCG, pers. comm., 1996.

Table 6. 1994 Motorboat Registrations in New York City.

County	Length (ft)						Total Number of Vessels
	<16'	16-25'	26-39'	40-65'	>65'	Uncoded	
Bronx	828	1366	408	33	14	17	2666
Kings	1429	2212	797	56	20	17	4531
New York	1024	1616	683	106	25	5	3461
Queens	2538	4243	995	79	17	22	7895
Richmond	1286	1915	599	49	13	12	3874
Total	7105	11354	3483	325	89	73	22,429

Source: New York State DMV, pers. comm. 1996

Table 7. 1996 Motorboat Registrations in New Jersey.

Category	Number of Vessels
Pleasure	184,927
Livery	1836
Commercial	3054
Total	189,819

Source: New Jersey State DMV, pers. comm. 1996

potential traffic in the New York Bight Apex. Futhermore, it is expected that tug/barge trips will continue to be a minor percentage of future commercial and recreational vessel traffic in the New York Bight Apex.

In conclusion, barges carrying the Material for Remediation, because of their low speed, are not expected to represent a significant collision hazard to humpback and fin whales. NMFS-certified observers (with marine mammal/sea turtle observation certification) on board the barge tugs will monitor for whales and sea turtles during transits to and from the HARS [refer to EPA Region 2/ USACE NYD (1997)]. It is expected that barges will attempt to avoid collisions with fin and humpback whales; collisions with loggerhead and ridley turtles are unlikely, because these animals spend most of their time in the Bight area foraging submerged in shallow coastal waters well away from the path of the barges. Underwater noise from motor vessels is not additive. Therefore, the low-frequency noise contributed to the underwater Bight environment from barge traffic will not add significantly to the total vessel noise in the area and will not contribute to disturbance of protected whales and sea turtles in the area.

4.4 Alternatives to Minimize Impact

4.4.1 Management Alternatives for the Proposed Action

1. **Possible event: Collision**
   Possible result: Injury or death of turtle or whale
   Management Alternative: Vessels transporting the Material for Remediation to the HARS will travel at slow speeds, usually well below 6 knots. Nevertheless, given the potential for collisions with whales or turtles, vessels transiting to and from the HARS will always carry a NMFS-certified observer/disposal inspector as a lookout to minimize encounters with endangered species. The observer would not only be experienced in spotting whales and turtles, but would also be experienced in advising vessel course changes to avoid collisions. Remediation Material placement operations will be prohibited at the HARS if endangered/threatened species are present.

2. **Possible event: Physical harassment**
   Possible result: Alter "normal" behavior, stop feeding, abandon feeding area, decrease maternal care.
   Management Alternative: Evidence from whale watching activities in Massachusetts Bay indicates that humpback and fin whales species readily acclimate to the presence of large and small motor vessels.

NMFS-certified inspectors will provide advice on course changes around whales and turtles that will minimize or eliminate the potential for harassment, if animals are spotted. There is no evidence of long-term effects due to physical disturbance from motor vessels.

3. **Possible event: Acoustic harassment**
Possible result: Short-term change swimming direction, breathing patterns; long-term: unknown
Management Alternative: The long-term effects of acoustic harassment are virtually unknown. Humpback and fin whales seem to acclimate readily to underwater noises produced by motor vessels. However, it is unclear if chronic elevated noise levels lead to behavioral modification in the whales. There is limited evidence that abrupt changes in vessel RPMs, which may occur during the actual placement of Material for Remediation, may temporarily disturb whales (Watkins 1986). Barge traffic will not contribute significantly to the total underwater background noise in the area and so should not be particularly disturbing to whales and sea turtles. The sensitivity of sea turtles to acoustic disturbances has not been well studied. Available evidence is that loggerhead and ridley turtles are only disturbed by intense underwater sounds, well above those produced by tugs towing loaded barges. Acoustic harassment from barges will be minimized by posting a NMFS-certified observer on board to spot the protected species and avoid close encounters with them.

4. **Possible event: Dispersal of prey**
Possible result: Increased feeding effort, possible decreased fitness.
Management Alternative: It is possible that the barge traffic could disperse the prey of whales and turtles that might be present in the HARS. However, the New York Bight Apex and, in particular, the HARS are not known to be significant feeding areas for whales and sea turtles. Nearly all sightings of feeding humpback and fin whales in the Bight area are in the eastern Bight off eastern Long Island. The few whales that have been sighted in the Bight Apex near the entrance to the port of New York/New Jersey probably were stragglers and were not actively feeding. Juvenile loggerhead and Kemp's ridley turtles feed in the New York Bight area almost exclusively in the shallow waters of bays and inlets where their preferred crustacean prey is most abundant. Water depths in the HARS area are too deep for routine foraging by these species. Therefore, the HARS and the shipping lanes between the HARS and the Port of New York and New Jersey are not important foraging areas for these protected species. Any dispersal of prey in this area, if it actually did occur, would not adversely affect the whales and sea turtles.

4.5 Alternatives to the Proposed Action

In this section, alternatives are compared to the Proposed Action.

4.5.1 BA Alternative 1 (SEIS Alternative 1): No Action

The MDS was designated by EPA in 1984 to receive up to 100 Myd^3 of dredged material. Since 1984, 68 Myd^3 have been disposed of at the MDS. Under BA Alternative 1, the MDS will be operated as specified in the 1997 USACE NYD/EPA Region 2 Site Management and Monitoring Plan (SMMP).

BA Alternative 1 will result in remediating ecological effects of degraded surface sediments existing within the northern and eastern portions of the MDS by capping them with the remaining capacity of 31 Myd^3 of Category I dredged material. However, an adverse result of BA Alternative 1 is that degraded sediments outside the MDS will not be capped/remediated under this alternative. Any remediation or redistribution of sediments in these areas will be by natural remediation and ongoing sedimentary processes.

The contour of the bottom in the MDS will change because of the further addition of dredged material to the site. The size of the current mounds of dredged material will substantially increase as disposal operations continue, especially in southern portions of the site. New small mounds may be formed throughout the site as specific disposal points (MDS project permits require discharge at specific coordinates for post-disposal monitoring purposes). The water depth over the site will measurably decrease and the slope of the bottom will increase along the flanks of the mound. However, the overall changes to bottom topography of the Bight Apex will be relatively small.

The change in water depth and topography is unlikely to adversely affect protected sea turtles and whales in the area. The protected species are not known to use the area of the MDS for foraging. Preferred prey of the sea turtles and whales are not known to be abundant in the area. The change in bottom topography could alter local oceanographic conditions, rendering the area more favorable for forage species, such as demersal crabs and sand lance. This could attract the protected species to the area. However, if this occurred, the change would be gradual and it is unlikely that the endangered species would increase foraging at the site while dredged material disposal is occurring. As discussed above, the potential for impact from dredged material disposal to the protected species, is considered to be low.

Under this alternative, the current potential for impacts to endangered and threatened species will continue until the remaining 31 Myd^3 of dredged material have been disposed. After this has been achieved, trips to the site will cease, the MDS will be closed, and there will be no disposal activity or placement of Material for Remediation-associated impacts to endangered and threatened species in the Bight Apex.

4.5.2 BA Alternative 2 (SEIS Alternative 2): Close MDS-No HARS Designation

Under BA Alternative 2, there would be a continued exposure of degraded sediments to the biotic zone of the New York Bight Apex. This scenario would not reduce the potential bioaccumulation of contaminants by benthic and demersal species living in the vicinity of the MDS or proposed HARS, and exposure of the species considered in this BA would remain at current levels.

4.5.3 BA Alternative 3 (SEIS Alternative 4): HARS Restoration

Under BA Alternative 3 (SEIS Alternative 4), only sandy Remediation Material (i.e., containing between 0-10% fines) will be used to cap degraded sediments of the HARS. The primary difference between this alternative and the Proposed Action is that this alternative will cover degraded sediments with sandy sediment (0-10% fines) rather than silty sediments, and return the site to pre-dredged material disposal conditions. The fact that this alternative will take 3-5 times longer than the Proposed Action, and leave degraded sediments in the HARS to potentially expose and impact endangered and threatened species (and other organisms) for a longer period, makes this alternative environmentally less preferable than the Proposed Action.

Similar to the Proposed Action, BA Alternative 3 impacts can be reduced or mitigated by selecting specific restoration methods, schedules, or sediments. However, unlike the Proposed Action, the use of only sandy Material for Remediation will change the existing mud-bottom habitats in the HARS to sand-bottom habitats. This habitat change is expected to affect benthic communities, and potentially (however remote) mud habitats of turtle prey. While the annual barge volume of traffic to the HARS will be less than the Proposed Action, the timeframe over which the traffic occurs is expected to be 3-5 times longer. The lengthening of the restoration period (compared to the Proposed Action) may present new or greater impacts to endangered turtles and whales, particularly if the visitation rates to the Bight Apex by these species increases in the intervening period.

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APPENDIX A

General Information on Contaminant Bioavailability, Bioaccumulation, Trophic Transfer, and Biomagnification in Marine Systems

The form of a chemical in the environment has a marked effect on the extent to which it can be bioaccumulated by and interact with the tissues to cause various biological effects, including toxicity, in the organisms themselves and their consumers, including protected species (Nelson and Donkin 1985; Waldichuk 1985). Only bioavailable chemicals may be bioaccumulated by marine organisms, possibly leading to biomagnification in marine food webs. Material proposed for ocean disposal is currently tested using toxicity and bioaccumulation tests; this will also be the case for placement of Material for Remediation at the HARS.

Bioavailability. Bioavailability is the extent to which a chemical can be absorbed or adsorbed by a living organism by active (biological) or passive (physical or chemical) processes. A chemical is said to be bioavailable if it is in a form that can move through or bind to the surface coating (e.g., skin, gill epithelium, gut lining, cell membrane) of an organism (Newman and Jagoe 1994). Many definitions of bioavailability also include the requirement that the chemical on or in the tissues of the organisms must be in a form that can react with cellular biochemicals, eliciting biological responses (Campbell *et al.* 1988).

The free ion and the aquo ions, (e.g., $M[OH]_2$ and $M[OH^-]$), in solution are considered the most bioavailable forms of most inorganic metals (Cowan *et al.* 1986; Nelson and Donkin 1985; Newman and Jagoe 1994). Metals in the form of the pure metal, precipitates, or heavy minerals are not bioavailable to marine organisms (Waldichuk 1985).

Organometallic compounds often are more bioavailable than the ionic inorganic forms of the metals. For example, methyl mercury and some other organomercurials are bioaccumulated more rapidly than inorganic mercury from water and food by marine animals (Fowler *et al.* 1978; Phillips and Buhler 1978). This appears to be due to the much slower release of organic than inorganic mercury from tissues of marine organisms. The methyl mercury in tissues of marine animals is derived primarily or exclusively from microbial methylation of inorganic mercury in hypoxic and anoxic layers in the water column and sediments (Rolfhus and Fitzgerald 1995; Gagnon *et al.* 1996). Marine and freshwater fish and invertebrates accumulate methyl mercury primarily from methyl mercury-contaminated food (Pentreath 1976; Fowler *et al.* 1978). Arsenic may behave similarly. Most of the arsenic in tissues of marine animals is organic and is bioaccumulated primarily from food and sediments (Neff 1997).

The bioavailability of organic chemicals to marine organisms also depends on the physical and chemical forms of the chemicals. Organic chemicals in true solution in sea water generally are much more bioavailable than organic chemicals that are present in complexed, adsorbed, or solid forms associated with suspended particles or sediments. Most of the chemicals of environmental concern are nonpolar (unionizable) and have a much lower solubility in water than in lipids in marine animal tissues (Davies and Dobbs 1984; Bierman 1990; Morrison *et al.* 1996). They partition from solution in ambient seawater across the gills and other permeable membranes into tissue lipids or from food in the digestive tract across the digestive epithelium.

Bioaccumulation. Bioaccumulation is the uptake and retention of a bioavailable chemical from any one of or all possible external sources (water, food, substrate, air). For bioaccumulation to occur, the rate of uptake from all sources must be greater than the rate of loss of the chemical from the tissues of the organism. Bioavailable chemicals diffuse passively or are transported across the outer membranes of the organism down a concentration or activity gradient. If the affinity of the tissues for the chemical is greater than that of the ambient water, the chemical may accumulate in the tissues to a higher concentration than its concentration in the ambient medium. Most toxic metals and nonpolar organic compounds of concern can bioaccumulate in tissues of marine organisms to concentrations hundreds or even thousands of times higher than their concentrations in the ambient water (Farrington and Westall 1986). Because marine turtles and whales have relatively little permeable body surface for direct uptake of chemicals from seawater, and concentrations of chemical contaminants in contaminated environments are much higher in tissues of food organisms than in the ambient water, these air-breathing animals acquire their body burdens of chemical contaminants almost exclusively from their food.

Trophic Transfer. The process of bioaccumulation of chemicals from food is called trophic transfer. Trophic transfer of contaminants in marine food webs involves many of the same physical and chemical processes that are involved in accumulation of contaminants from water and sediments. However, bioaccumulation occurs primarily or exclusively in the unique environment of the gut of the consumer. Contaminants introduced into the gut of the consumer sorbed or bound to the tissues of the prey item may desorb from the food and dissolve in the gut fluids during digestion and then partition from the gut fluids across the gut epithelium into the tissues of the consumer (Gobas *et al.* 1993).

Contaminants may be spread throughout a marine food web by trophic transfer. If the trophic transfer is reasonably efficient and the consumers at each trophic level in the food web are inefficient in excreting the contaminants, the contaminants may biomagnify in the food web (Connell 1989; Gobas *et al.* 1993).

Biomagnification. Biomagnification is the process whereby a chemical, as it is passed through a food chain or food web by trophic transfer, becomes increasingly concentrated in the tissues of animals at each higher trophic level. Biomagnification should be measured on a whole-animal basis or on the basis of lipid-normalized tissue weight (for nonpolar organic chemicals) (Connell 1989; Leblanc 1995). Bioaccumulation of a nonpolar organic chemical in a lipid-rich tissue of a predator (e.g., liver or depot fat) to a concentration higher than that found in the prey is not necessarily biomagnification. Conversely, biomagnification is demonstrated when the lipid-normalized concentration of a nonpolar organic contaminant is higher in the tissues of the predator than in the prey.

Methyl mercury behaves differently. It is no more lipid-soluble than inorganic mercury, but instead is bound in tissue to proteins, particularly in muscle (Mason *et al.* 1995). Thus, biomagnification of organo-mercury compounds is defined in terms of residues in whole soft tissues of marine animals at different trophic levels in a marine food web (Minganti *et al.,* 1996).

The only organic chemicals for which biomagnification has been convincingly demonstrated in marine food chains are highly hydrophobic (log K_{ow} greater than about 4.0). Differential biomagnification of different PCB and polychlorinated dibenzodioxin congeners is related to degrees of chlorination and ability of different members of the food web to metabolize and excrete different congeners, preventing their biomagnification. Polycyclic aromatic hydrocarbons (PAHs) are readily metabolized and excreted by most species of marine invertebrates, fish, birds, and mammals and so do not biomagnify in marine food webs, even those that include air breathing top predators (Broman 1990; Broman et al. 1990). Methyl mercury is the only non-essential metal-organic compound that has been shown to biomagnify in marine food webs (Young 1988; Minganti *et al.* 1996).

Some inorganic metals appear to biomagnify in tissues of marine invertebrates and fish. In many cases these metals are sequestered in the form of insoluble, inert metal granules in selected tissues, particularly the kidney (Simkiss and Taylor, 1989). These metal-rich granules may accumulate in the tissues of the animals for their whole life times, resulting in an increase in tissue concentrations with age and size. The metals in the metal-rich granules are not bioavailable to the host and are not passed through marine food webs (Nott and Nicolaidou, 1990, 1994). Pilot whales (*Globicephala melas* and *P. macrorhynchus*). Atlantic bottlenose dolphins (*Tursiops truncatus*), and perhaps some other species of cetaceans, bioaccumulate organic mercury to high concentrations and store it as inorganic mercuric selenide complexes in the liver and lungs (Martoja and Berry 1980; Rawson *et al.* 1995; Caurant *et al.*, 1996). Thus, organic mercury is demethylated and stored in a non-toxic form in the whale tissues. The whales also are highly tolerant to cadmium and store it in an as yet unknown form, probably solid concretions, primarily in the kidneys (Martoja and Martoja 1985). Long-term sequestration of metals in inert forms in tissues does not, strictly speaking, represent biomagnification, because the chemicals are not in a bioavailable form that can cause harm to the host.

Biomagnification of highly hydrophobic chemicals is more likely to occur in marine food webs in the trophic step from water-breathing prey to air-breathing predator, because the air-breathing consumer can not release the highly hydrophobic chemical by passive diffusion through permeable membranes (Muir *et al.* 1988). For example, concentrations of polychlorinated biphenyls (PCBs) in a Canadian arctic food chain increase from an average of 60 to 151 ng/g lipid in plankton (depending on plankton size), to 333 ng/g lipid in pelagic fish, and 2,328 ng/g lipid, 882 ng/g lipid, 5,525 ng/g lipid, and 2,875 ng/g lipid in ringed seals, polar bears, and beluga whales, respectively (Hargrave *et al.*, 1992).

Appendix A References

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