U.S. ARMY CORPS OF ENGINEERS
PHILADELPHIA DISTRICT

A BIOLOGICAL ASSESSMENT FOR POTENTIAL IMPACTS TO FEDERALLY LISTED THREATENED AND ENDANGERED SPECIES OF SEA TURTLES, WHALES AND THE SHORTNOSE STURGEON RESULTING FROM THE DELAWARE RIVER MAIN STEM AND CHANNEL DEEPENING PROJECT

JANUARY 2009

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1.0 INTRODUCTION

1.1 PURPOSE

Section 7 of the Endangered Species Act, as amended November 10, 1978, requires that a Biological Assessment be prepared on all major Federal actions involving construction when Federally listed or proposed endangered or threatened species may be affected. The purpose of this assessment is to update the original biological assessment conducted by the Philadelphia District of the USACE in September 1995 focusing exclusively on the District's Delaware River Main Stem and Channel Deepening project. This assessment considers the potential impacts to listed threatened and endangered species within the project area. Listed species that may occur within this project include right, humpback, and fin whales; loggerhead, leatherback, Kemp's ridley, hawksbill and green sea turtles; and shortnose sturgeon. All of these species are endangered, except for the loggerhead sea turtle, which is listed as threatened.

1.2 ENDANGERED SPECIES ACT

This "biological assessment" is part of the formal consultation process provided under Section 7 of the Endangered Species Act. Detailed procedures for this consultation process are defined in 50CFR402.

1.3 JEOPARDIZED SPECIES

The primary concern with sea turtles, whales, and shortnose sturgeon is whether or not impacts associated with the Delaware River Deepening project "jeopardizes their continued existence." Federal regulation defines this term as "engaging in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of the listed species in the wild by reducing the reproduction, numbers, or distribution of that species."

1.4 CHRONOLOGY OF EVENTS LEADING UP TO THIS ASSESSMENT

In September 1986 the Philadelphia District initiated formal consultation under Section 7 of the Endangered Species Act of 1977 (16 U.S. C. 1531 et seq.), with regard to maintenance dredging of Delaware River Federal Navigation Projects from Trenton to the Sea, and potential impacts to the Federally endangered shortnose sturgeon (*Acipenser brevirostrum*). "A Biological Assessment of Shortnose Sturgeon (*Acipenser brevirostrum*) Population in the Upper Tidal Delaware River: Potential Impacts of Maintenance Dredging" was forwarded to NMFS for their review.

It was determined by the Corps that maintenance dredging activities in the southern reaches of the Delaware River, specifically from Philadelphia to the Sea, were not of concern with respect to impacting shortnose sturgeon. The area, between

Philadelphia and Wilmington, was considered the "pollution zone" and was only utilized as a migratory route by adults during the early spring and late fall. This area is no longer considered a pollution zone and is utilized by shortnose sturgeons (Green, 2000; ERC 2004, 2005, 206a, 2006b, 2007). South of Wilmington the shortnose sturgeon population is limited to adults due to increased salinity.

In September 1995, the Philadelphia District again initiated formal consultation under the Endangered Species Act with regard to potential impacts associated with dredging projects permitted, funded or conducted by the Philadelphia District. "A Biological Assessment of Federally Listed Threatened and Endangered Species of Sea Turtles, Whales, and the Shortnose Sturgeon within Philadelphia District Boundaries: Potential Impacts of Dredging Activities" was forwarded to NMFS for their review. A Biological Opinion was issued by the NMFS on November 26, 1996 (Montanio, 1996) for all dredging projects carried out by the District. The Opinion stated that dredging projects within the Philadelphia District may adversely affect sea turtles and shortnose sturgeon, but are not likely to jeopardize the continued existence of any threatened or endangered species under the jurisdiction of the NMFS. For projects within the Philadelphia District, the anticipated incidental take by injury or mortality is three (3) shortnose sturgeon. This Opinion was amended with a revised Incidental Take Statement (ITS) on May 25, 1999.

In letters dated 14 February 1997 and 29 December 1997, the United States Department of Commerce, the parent agency of the National Marine Fisheries Service (NMFS), stated that the Biological Opinion issued by the NMFS in 1996 does not cover blasting. They further stated that sea turtles and marine mammals are not likely to be found in the Marcus Hook area where blasting will occur for the deepening project, but shortnose sturgeon may be found in the area. This is due in part to the fact that the Chester - Philadelphia "pollution zone no longer exists" (Fruchter, 1997). They requested that the Corps continue to coordinate with the NMFS to ensure compliance with the requirements of the Endangered Species Act. In May 2000 the Philadelphia District submitted a Biological Assessment of the required rock blasting in the Marcus Hook navigational range of the main channel deepening project. On January 31, 2001 NMFS issued their Biological Opinion which concluded that rock blasting conducted from December 1 to March 15 may adversely affect, but is not likely to jeopardize the continued existence of listed species under NMFS' jurisdiction.

Since that time, the project was delayed for several years due to sponsorship uncertainties. In May 2007, the Philadelphia Regional Port Authority (PRPA) took over sponsorship of this project from the Delaware River Port Authority. In June 2008, the Corps and the PRPA executed a Project Partnership Agreement for construction of the Delaware Main Stem and Channel Deepening

Project from 40 feet to 45 feet. In December 2008, the NMFS requested that the Corps reinitiate consultation for the Delaware deepening project in light of new information available regarding shortnose sturgeon and their use of the Delaware River. The NMFS also requested information regarding "any expected port expansion that is expected to result from the proposed deepening". The 45-foot project was formulated, evaluated, and authorized by Congress based on the parameter that no tonnage will be induced or attracted to the port's facilities as a direct result of the proposed deepening of the channel depth for the five-foot increment from 40 to 45 feet. Any future increase in the amount of tonnage through the port over the project life will be an equivalent amount for either the 40 or 45 foot channel depth conditions, and would be predicated on the performance of the U.S. economy. A deeper channel will allow vessels to more efficiently apportion vessel operating costs over the same magnitude of tonnage, resulting in transportation savings. The largest vessels in the fleet, crude oil tankers, will continue to carry the same amount of imported crude to the Big Stone Beach anchorage (located in the naturally deeper water in the lower Delaware Bay). The Coast Guard allowance for sailing drafts of the tankers into the anchorage is 55 feet. Lightering requirements will be reduced for these tankers with the channel deepening, which will lessen the number of barge trips required to carry crude to the refineries upriver. So, overall, the total vessel/barge traffic through the Delaware River port system will be less with the 45 foot deepening as compared to the traffic for the existing 40 foot channel depth.
Overall, future cargo growth is expected to be modest (with flat tonnage factored for crude oil and petroleum products, and only small to moderate growth for dry bulk and container traffic). In summary, the 45 foot channel depth improvement would not necessitate any expansion of the port facilities utilized for tonnage with the current 40 foot channel scenario.

1.5 PROJECT BACKGROUND

Established in 1866, the Philadelphia District is responsible for the Federal role in water resource development projects in the Delaware River Basin, and for Federal navigation projects in the Delaware, Schuylkill, Salem and Christina Rivers, the Intracoastal Waterway (IWW) of New Jersey from Manasquan Inlet to Cape May, and the IWW Delaware River to Chesapeake Bay – Chesapeake and Delaware Canal. The Delaware River has three major sub-basins: the Schuylkill, Lehigh, and Lackawaxen in Pennsylvania. Other basin rivers include the Neversink, Cooper, Assiscunk in New Jersey, and the Brandywine in Pennsylvania.

The Philadelphia District keeps the Delaware River ports, which include Philadelphia, Camden, and Wilmington, economically viable by maintaining an authorized 40-foot depth in the Delaware River navigation channel from Newbold Island in Bucks County north of Philadelphia, to deepwater in the Delaware Bay. Another project is a six-mile reach of the Schuylkill River in

Philadelphia. Other projects include federally authorized navigation channels in waterways and inlets in New Jersey, Delaware, and Maryland, including the Chesapeake & Delaware Canal connecting the Delaware River and Upper Chesapeake Bay, Salem River and the Manasquan, Barnegat and Cape May Inlets in New Jersey, and Wilmington Harbor and Indian River Inlet in Delaware.

The existing Delaware River, Philadelphia to the Sea, Federal navigation project was adopted by Congress in 1910 and modified in 1930, ’35, ’38, ’45, ’54 and ’58. The existing project provides for a channel from deep water in Delaware Bay to a point in the bay, near Ship John Light, 40 feet deep and 1,000 feet wide; thence to the Philadelphia Naval Base, 40 feet deep and 800 feet wide, with a l,200-foot width at Bulkhead Bar and a 1,000-foot width at other channel bends; thence to Allegheny Avenue Philadelphia, PA; 40 feet deep and 500 feet wide through Horseshoe Bend and 40 feet deep and 400 feet wide through Philadelphia Harbor along the west side of the channel. The east side of the channel in Philadelphia Harbor has a depth of 37 feet and a width of 600 feet. All depths refer to mean low water. The 40-foot channel from the former Naval Base to the sea was completed in 1942. The channel from the former Naval Base to Allegheny Avenue was completed in 1962.

There are 19 anchorages on the Delaware River. The Mantua Creek, Marcus Hook, Deepwater Point, Reedy Point, Gloucester and Port Richmond anchorages are authorized under the Philadelphia to the sea project. The remaining 13 are natural, deep-water anchorages. The authorized anchorage dimensions are as follows:

Mantua Creek:	40’ X 2,300’ X 11,500’ (mean)
Marcus Hook:	40’ X 2,300’ X 13,650’ (mean)
Deepwater Point:	40’ X 2,300’ X 5,200’ (mean)
Reedy Point:	40’ X 2,300’ X 8,000’ (mean)
Port Richmond:	37’ X 500’ (mean) X 6,400’
Gloucester:	30’ X 400’ (mean) X 3,500’

Mantua Creek anchorage is currently maintained to about 60% of the authorized width and a 37-foot depth. The Marcus Hook anchorage, enlarged in 1964, is maintained to authorized dimensions. The anchorage at Port Richmond is about 35 feet deep, as are the Reedy Point and Deepwater Point anchorages. The Gloucester anchorage requires no dredging and is currently deeper than authorized.

There are wide variations in the amount of dredging required to maintain the Philadelphia to the sea project. Some ranges are nearly self maintaining and others experience rapid shoaling. The 40-foot channel requires annual maintenance dredging in the amount of 3,455,000 cubic yards. Of this amount, the majority of material is removed from the Marcus Hook (44%), Deepwater Point

(18%) and New Castle (23%) ranges. The remaining 15 percent of material is spread throughout the other 37 channel ranges. The historic annual maintenance quantities for the Marcus Hook and Mantua Creek anchorages are 487,000 and 157,000 cubic yards, respectively.

The Federal government has the responsibility for providing the necessary dredged material disposal areas for placement of material dredged for project maintenance. There are currently seven upland sites in the riverine portion of the project and one open-water site, located in Delaware Bay, that are used for this purpose. The seven confined upland sites are National Park, Oldmans, Pedricktown North, Pedricktown South, Penns Neck, Killcohook and Artificial Island. The open water site in Delaware Bay is located in the vicinity of Buoy 10. This site is only approved for placement of sand.

1.6 LOCATION

The Philadelphia District's five-state area covers nearly 13,000 square miles of the Delaware River Basin, encompassing most of Delaware, eastern Pennsylvania, western and southern New Jersey, a portion of northeastern Maryland at the Chesapeake & Delaware Canal, and several counties in the western Catskills area of New York where the Delaware rises.

This assessment addresses USACE dredging activities related to the Delaware River Main Channel Deepening Project.

1.6.1 DELAWARE RIVER AND BAY DESCRIPTION

The Delaware River Estuary is 132 miles (211 kilometers) long and extends from Cape May and Cape Henlopen to Trenton, New Jersey. The region of the estuary that is referred to as Delaware Bay is 75 miles (120 kilometers) long and extends from the Capes to a line between stone markers located at Liston Point, Delaware and Hope Creek, New Jersey (Polis et al., 1973). The estuary varies in width from 11 miles (18 kilometers) at the Capes; to 27 miles (43 kilometers) at its widest point (near Miah Maull Shoal); to 1,100 feet (0.3 kilometer) at Trenton, New Jersey. Water depth in the bay is less than 30 feet (9.1 meters) deep in 80 percent of the bay and is less than 10 feet (3 meters) deep in much of the tidal river area. A navigation channel passes from deep water inside the entrance of the bay to Trenton, New Jersey. Authorized depth of the channel is 40 feet (12.1 meters) below mean sea level up to the upper end of Newbold Island and then 25 feet (7.6 meters) below mean sea level to Trenton.

Artificial Island is located approximately 2 miles (3.2 kilometers) upstream of the hypothetical line demarking the head of Delaware Bay. The tidal river in this area narrows upstream of Artificial Island and makes a bend of nearly 60 degrees. Both the narrowing and bend are accentuated by the presence of

Artificial Island. Furthermore, more than half of the typical river width in this area is relatively shallow, less than 18 feet (5.5 meters), while the deeper part, including the dredged shipping channel has depths of up to 40 feet (12.1 meters). The largest tributaries of the Delaware Estuary are the Schuylkill River in Pennsylvania, the Christina River in Delaware, and the Assiscunk, Crosswicks, Rancocas and Salem Rivers, and Big Timber, Hope and Alloways Creeks in New Jersey (PSE&G, 1984). The head of the Delaware Estuary is at Trenton, New Jersey, about 84 miles (135 kilometers) upstream of Artificial Island. The Chesapeake and Delaware Canal, which connects the Delaware River with Chesapeake Bay, is located approximately 7 miles (11.3 miles) north of Artificial Island.

The Delaware River between the fall line at Trenton (river km 222; river mile 138) and Philadelphia (rkm 161; rmi 100) is tidal freshwater with semidiurnal tides. At Newbold Island (rkm 201; rmi 125) the daily vertical tidal fluctuation is usually about 2.0 m, but maximum tidal amplitudes may reach 4.2 m (Anselmini, 1971). Mean tidal range at Trenton is 6.8 ft. (2 m) and at Philadelphia 5.9 ft (1.8 m) (U.S. Army Engineer District, 1975). River flow at Trenton averages 11,772 cubic feet per second, but varies from 1180 cfs (in 1963) to 329,000 cfs (in 1975) (Brundage, 1982b). Mean tidal flow at Newbold Island is about 40,000 cfs (Anselmini, 1971). Water pH generally is about 6-8.

Of the total freshwater flow into the Delaware Estuary, annual average of 23,352 cubic feet per second (661 cubic meters per second), approximately 50 percent (11,759 cfs or 333 cubic meters per second) is contributed by the Delaware River at Trenton; 12 percent (2,715 cfs or 76.9 cubic meters per second) by the Schuylkill River; and, the remaining 38 percent by all other tributaries (USGS, 1981a; USGS, 1981b).

Tidal flow as measured near the Delaware Memorial Bridge, 20 miles above Artificial Island, was measured at 399,710 cfs (11,320 cubic meters per second) (USGS, 1966). Tidal flow of this magnitude is 17 times as great as the total average freshwater flow rate into the estuary. Proceeding toward the mouth of the estuary, tidal flow increasingly dominates freshwater downstream flow; proceeding upstream from the Delaware Memorial Bridge, the ratio of tidal flow to net downstream flow becomes smaller as tidal influence decreases.

2.0 PROJECT DESCRIPTION OF THE MAIN CHANNEL DEEPENING

The authorized deepening project as shown on Figure 1 provides for modifying the existing Delaware River Federal Navigation channel (Philadelphia to Sea Project) from 40 to 45 feet at Mean Low Water) with an allowable dredging overdepth of one foot, following the existing channel alignment from Delaware Bay to Philadelphia Harbor, Pennsylvania and Beckett Street Terminal, Camden, New Jersey. The channel side slopes are 3

horizontal to 1 vertical. The project also includes deepening of an existing Federal access channel at a 45-foot depth to Beckett Street Terminal, Camden, New Jersey.

The existing channel is maintained at a depth of 40 feet deep at mean low water. Only portions of the channel that are currently between 40 feet and 45 feet at mean low water will be dredged for the deepening project. The surface area of the Delaware estuary from the Ben Franklin Bridge to the capes (excluding tidal tributaries) is approximately 700 square miles. The Philadelphia to the sea Federal navigation channel has a surface area of 15.3 square miles, or approximately 2.2 percent of the total estuary surface area. For the 45-foot deepening project, 8.5 square miles would be dredged; this is 1.2 percent of the total estuary surface area and 55 percent of the existing channel. The remaining 6.8 square miles of the existing channel is already 45 feet deep or deeper.

The channel width (same as the existing 40-foot project) is 400 feet in Philadelphia Harbor (length of 2.5 miles); 800 feet from the Philadelphia Navy Yard to Bombay Hook (length of 55.7 miles); and 1,000 feet from Bombay Hook to the mouth of Delaware Bay (length of 44.3 miles). The project includes 11 bend widenings at various ranges as listed below as well as provision of a two space anchorage to a depth of 45 feet at Marcus Hook, Pennsylvania (Table 1). The existing turning basin adjacent to the former Philadelphia Naval Shipyard will not be deepened as part of the 45 foot project.

It should also be noted that the Miah Maull - Cross Ledge bend is no longer being widened as part of this project. Also included as part of the Federal project is the relocation and addition of buoys at the 11 modified channel bends. Ten new buoys are proposed: Philadelphia Harbor (2), Tinicum Range (1), Eddystone Range (1), Bellevue Range (3), Cherry Island Range (1), Bulkhead Bar Range (1), and Liston Range (1).

The following channel bends will be modified:

1. LISTON-BAKER: Maximum width increase on the east edge of 250 feet, over a distance of 4,500 feet south of the apex, and extending 3,900 feet north from the apex (BW2 - channel station 275 + 057);

2. BAKER-REEDY ISLAND: 100-foot width increase at the west edge apex of the bend over a distance of 3500 feet both north of and south of the apex (BW3 - channel station 265 + 035);

3. REEDY ISLAND-NEW CASTLE: Maximum widening of 400 feet at the west apex of the bend, tapering to zero over a distance of 3,200 feet south of the apex and to zero over a distance of 4,000 feet north of the apex (BW4 - channel station 238 + 982);

Figure 1. Delaware River Main Channel Deepening Project

4. NEW CASTLE-BULKHEAD BAR AND BULKHEAD BAR-DEEPWATER: The west edge of Bulkhead Bar range is extended by 300 feet to the south and 300 feet to the north; the widening tapers to zero at a distance of approximately 3,000 feet south of the south end of Bulkhead Bar and 3,000 feet north of the north end of Bulkhead bar (BW5 - channel station 212 + 592 and 209 + 201);

5. DEEPWATER-CHERRY ISLAND: A maximum channel widening of 375 feet is required at the western apex of the bend. The widening tapers to zero at a distance of about 2,000 feet both north and south of the apex (BW6 - channel station 186 + 331);

6. BELLEVUE-MARCUS HOOK: The east apex of the bend requires a 150 foot widening over existing conditions, along a total length of approximately 4,000 feet (BW7 - channel station 141 + 459);

7. CHESTER-EDDYSTONE: The southwest apex of the bend requires a maximum 225 foot widening, with a transition to zero at the northeast end of Eddystone range, over a linear distance of approximately 6,000 feet (BW8 - channel station 104 + 545);

8. EDDYSTONE-TINICUM: The northeast apex of this bend requires a 200 foot widening, with a transition to zero at a distance of about 1,200 feet northeast and southwest of the bend apex (BW9 - channel station 97 + 983);

9. TINICUM-BILLINGSPORT: The north channel edge of Billingsport was widened by 200 feet. At the northern apex of the Tinicum-Billingsport bend, this results in a maximum widening of approximately 400 feet, with a transition to zero at a distance of about 2,000 feet west of the apex (BW10 - channel station 79 + 567);

10. BILLINGSPORT-MIFFLIN: The south apex of the bend was widened a maximum of 200 feet to the south, and transitioned to zero at a distance of approximately 3,000 feet northeast of the apex (BW11 - channel station 72 + 574);

11. EAGLE POINT-HORSESHOE BEND: The northwest edge of Horseshoe Bend requires a maximum widening of 490 feet to the north. The widening transitions to zero at a distance of approximately 4,000 lineal feet west of the west end of Horseshoe Bend, and at a distance of 1,500 lineal feet north of the north end of the bend (BW12 - channel station 44 + 820 to 41 + 217).

Table 1 - Bend Modification Summary (Listed from Downstream to Upstream)

Bend Modifications	Area (Acres)	Substrate	Mean Elevation (Feet)
Listen - Baker	31.0	Silt	43.3
Baker – Reedy Island	2.8	Sand	41.4
Reedy Island – New Castle	21.7	Silt	42.8
New Castle – Bulkhead Bar and Bulkhead Bar - Deepwater	7.7	Sand	41.2
Deepwater – Cherry Island	12.1	Silt	42.6
Bellevue – Marcus Hook	11.4	Silt	43.5
Chester - Eddystone	12.3	Silt	41.1
Eddystone - Tinicum	11.3	Sand	42.1
Tinicum - Billingsport	55.4	Silt	39.6
Billingsport – Mifflin	7.7	Sandy-Silt	43.0
Eagle Point – Horseshoe Bend	42.5	Sandy-Silt	38.3
Total Area	**215.9**		

Construction and maintenance of the 45-foot project for a 50-year period will only utilize existing, Federally owned confined disposal facilities. The current dredged material disposal plan for the riverine portion of the project will only utilize the existing Federal sites (National Park, Oldmans, Pedricktown North, Pedricktown South, Penns Neck, Killcohook, Reedy Point North, Reedy Point South, and Artificial Island). In Delaware Bay, material will be used for beneficial use projects at Kelly Island and Broadkill Beach. Since completion of the Supplemental Environmental Impact Statement in 1997, further engineering studies have reduced the quantities of material to be dredged (initial and maintenance) thereby reducing the amount of disposal capacity needed. Due to the decrease in overall project quantities, the previously proposed beneficial use project at Egg Island Point is being deferred at this time.

2.1 INITIAL CONSTRUCTION

For the initial deepening, approximately 16 million cubic yards (cy) of material would be dredged and placed by hydraulic and hopper dredges in confined upland disposal facilities in the Delaware River portion of the project area and for beneficial

uses in Delaware Bay (See Figure 1). In addition, 77,000 cubic yards of rock would be removed in the vicinity of Marcus Hook, Pennsylvania and placed in the Fort Mifflin confined disposal facility in Philadelphia. The initial dredging quantities and placement locations are distributed among the project reaches as follows:

Table 2. Summary of initial dredging quantities and planned placement site of dredged material.

Navigational Range	Cubic Yards to be dredged	Placement Site
Reach AA	994,000	National Park
Reach A	1,666,630	Pedricktown North
Reach B	4,664,900	Pedricktown North and South, Oldmans
Reach C	2,502,800	Killcohook No. 2, Reedy Point South
Reach D	2,051,100	Reedy Point South, Artificial Island
Reach E	4,081,700	Kelly Island, Broadkill Beach
Total	Approximately 16,000,000	

Dredging equipment is described in Sections 3.1.2.3 and 10.4.2.1 of the 1997 Supplemental Environmental Impact Statement. The channel dredging project will use hopper and cutterhead dredges. See Section 3.0 of the 1997 SEIS. Rock will be removed from the channel with an excavator.

Initial construction is currently expected to begin no earlier than the summer/fall of 2009. It is anticipated that initial construction will take approximately 5 years to complete. More details on the construction schedule can be found in Section 2.4 of this assessment.

2.2 BENEFICIAL USE OF DREDGED MATERIAL

As stated above, it is anticipated that approximately 16 million cy of material will be removed from the channel during initial construction. The required maintenance dredging of the 45-foot channel will increase by 862,000 cubic yards per year (cy/yr) from the current 3,455,000 average cy/yr for the 40-foot channel for a total of 4,317,000 cy/yr. There are currently no upland disposal sites in the Delaware Bay portion of the project. Sand from maintenance dredging activities in this area is currently placed in an open water disposal site (Buoy 10). In order to minimize the need for open water disposal, the Corps investigated beneficial uses for the sand dredged from this portion of the project. As a result of these investigations, approximately 4 million cy of suitable material removed from the

channel will be used for wetland restoration or beach nourishment. Descriptions of the proposed beneficial use sites are provided below.

2.2.1 KELLY ISLAND (DELAWARE)

The Kelly Island wetland restoration plan has been refined since the publication of the 1997 SEIS based on coordination with DNREC, NMFS and the US Fish and Wildlife Service. An updated description appears below.

The main purposes of the Kelly Island wetland restoration project are to restore intertidal wetlands using dredged sediment from the deepening of the Delaware River navigation channel, stem erosion of the Kelly Island shoreline estimated at 20 feet per year, provide extensive sandy beach for spawning horseshoe crabs, and provide continued protection to the entrance of the Mahon River.

Restoring wetlands in this environmentally sensitive area has been a high priority for the State of Delaware. A plan has been developed with the assistance of the Federal and State resource agencies to restore 60 acres of intertidal habitat (Figures 2 and 3). The site will be constructed as an impoundment and remain as such until the sediments consolidate and vegetation becomes established. At that time, the State of Delaware will decide whether to open the site up to unregulated tidal inundation. The option to convert back to an impoundment will be maintained. Following construction, the site will be monitored to insure that the goals of the project are met and that no adverse impacts occur, particularly impacts to oyster beds.

Features of the project include:

- Sixty acres of wetlands where the substrate will consist of an estimated 55,000 cubic yards of silt and 645,000 cubic yards of sand.
- An offshore containment dike made of 1.7 million cubic yards of sand that will provide up to 5,000 linear feet of sandy beach. The crest of the dike will be at +10 ft MLW providing substantial spawning habitat for horseshoe crabs.
- A geotextile tube within the core of the offshore dike that provides overwash protection and contingency protection against breaching.
- Timber groins to limit sand transport along the beach.
- Option for water level control or free tidal exchange with the bay.

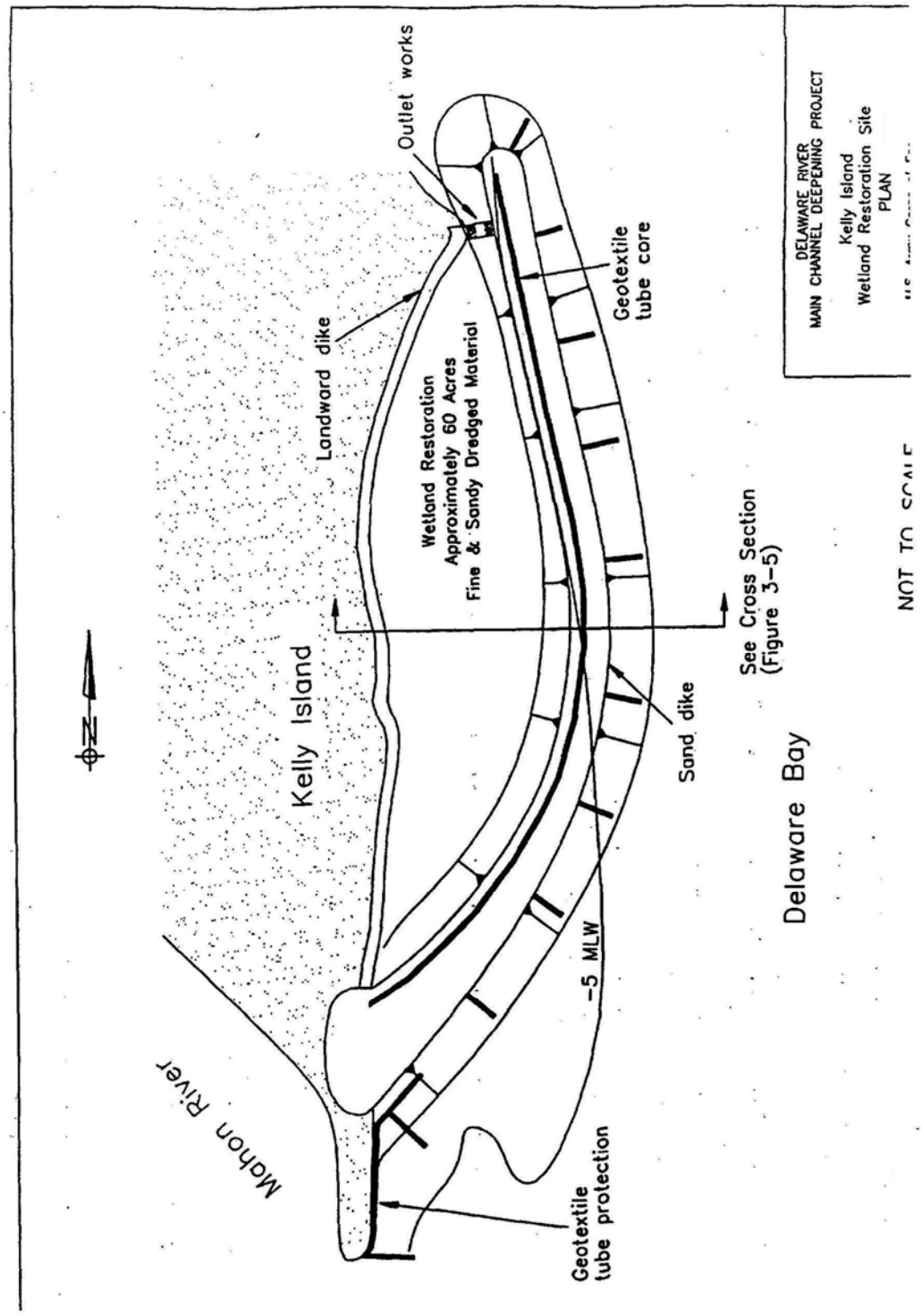

Figure 2. Kelly Island Plan

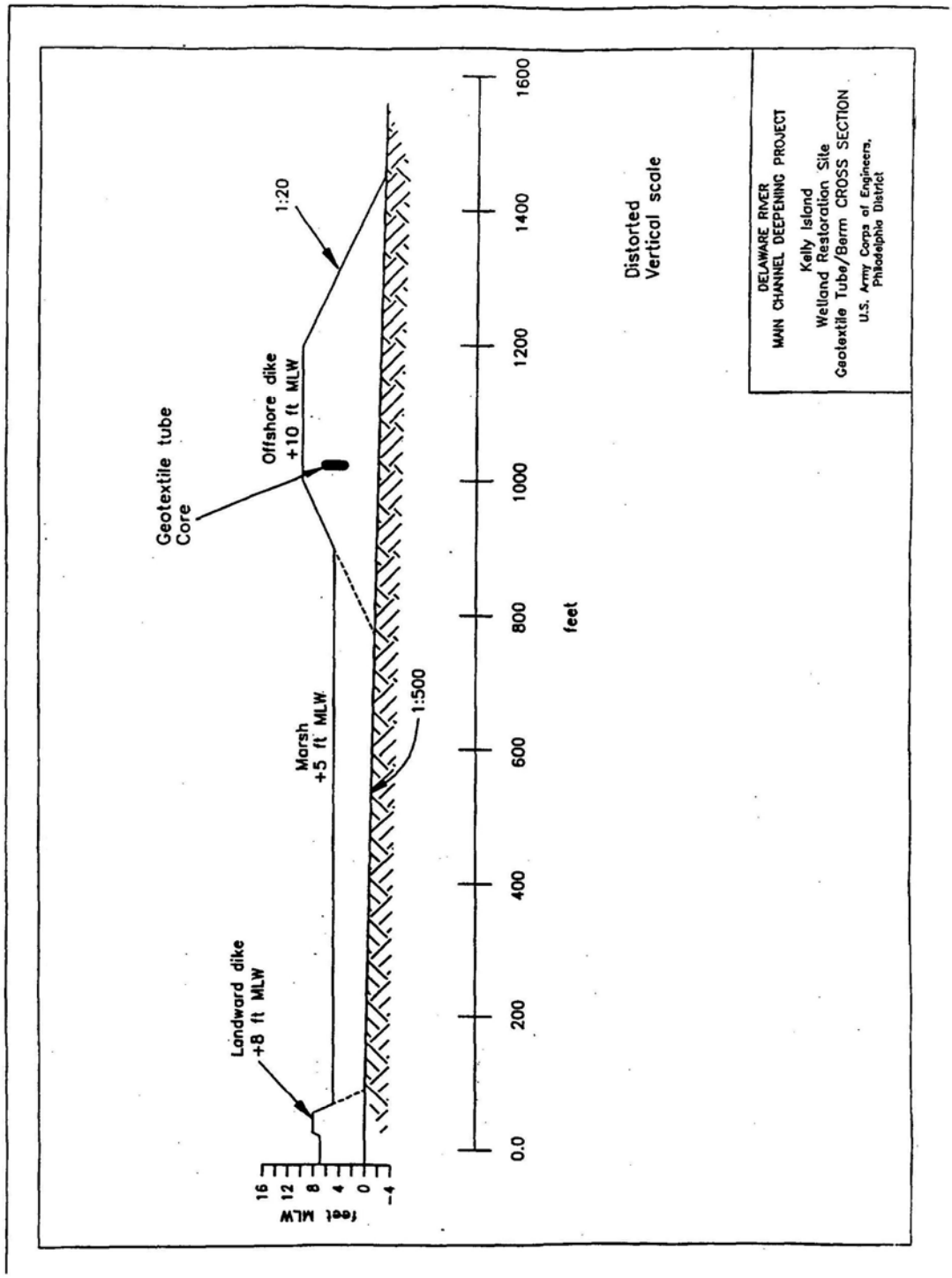

Figure 3. Kelly Island Geotextile Tube

Construction of the sand dikes will begin at the south end gaining access to the site from the Mahon River channel. Once the dikes are constructed, the interior will be filled. Filling will take approximately 4 months. The total time to construct Kelly Island is 6 months. Construction is scheduled to occur between April and September to preclude potential dredging impacts to overwintering blue crabs between December and March. Once the containment area/beach is constructed, fine-grained sediment will be placed first followed by placement of sand. The volume of sediment to be placed in the site will ultimately achieve a surface elevation of +5 feet MLW which is at the upper part of the tidal range. After construction, and possibly for several years, the water levels in the site will be controlled.

The offshore dike will have a crest elevation of +10 feet MLW. This elevation is coincident with the water level for a return interval between 10 and 25 years. It is only during rare events that this sand dike will be overtopped. The dike is expected to provide up to 5,000 linear feet of spawning habitat for horseshoe crabs.

The crest width of the dike will be 200 feet at its narrowest and 350 feet at its widest. The volume of sand in the cross section of the dike will be constant, i.e. 845 cubic yards per linear yard. Therefore, the crest width of the dike in shallow water will be greater than in deeper water. The total volume of sand required for the offshore dike is 1.7 million cubic yards (which includes a quantity sufficient to offset an estimated one foot of settlement). The offshore slope of the dike is estimated to be initially 1:20, and after the first year of "weathering" it should equilibrate to a milder 1:40 slope.

The southern end of the offshore dike will terminate on the island. The elevation of the crest of the dike will transition from +10 feet MLW to the +7 feet MLW (approximate) elevation of the existing marsh. The dike will extend onto the island far enough to prevent southerly waves at high water levels from damaging any portion of the interior of the project. The dike will also extend beyond its connection with the landward dike.

The northern end of the offshore dike will extend approximately 300 feet beyond Deepwater Point roughly parallel to the shoreline. The outlet works for the project will be placed at Deepwater Point, and so the offshore dike will protect that location.

A geotextile tube will be placed within the offshore dike as a factor of safety against a breach in the dike due to an extreme event and overwash. The crest of the tube will be placed to a crest elevation of +7 feet MLW. The tube will then be buried under an additional three feet of sand bringing the crest of the dike up to elevation +10 feet MLW. The protection that the tube provides should allow time for maintenance or repair work to be planned and executed if a breach should develop due to overwash.

A landward dike will be constructed along the edge of the existing marsh with a crest elevation of +8 feet MLW. The dike crest width will be 20-30 feet. The dike will prevent dredged material from flowing across or settling in the existing marsh. The dike will be built-up by trucking sand from the larger offshore dike to the landward dike during construction. The dike will not be constructed by hydraulic placement of sand. The dike will be left in place after construction to impound the site. In the future, if the State of Delaware decides that the site should function with unregulated tidal exchange with the bay, the landward dike may be removed. However, if the capability to impound the site at some future date is necessary, then the landward dike should not be removed.

Sheetpile groins made of either timber or vinyl will be placed along the perimeter of the offshore dike to help limit longshore transport. Although the cross-section of the dike is designed to sustain sediment losses for many years without losing any of its function, groins will increase the longevity of the project, reduce potential maintenance, and add a factor of safety against the risk that sand will be transported south along the project into the Mahon River entrance. The groins will extend seaward from the crest of the dike about 240 feet. They will extend landward from the crest of the dike about 50 feet. Therefore, their total length is 290 feet. The groins will follow the initial profile of the dike having a 1:20 slope from the crest of the berm to MLW. The crests of the groins will be nominally about 2 feet above the sand berm initial cross-section. The groins will be spaced about 750 feet apart. At both ends of the project, terminal timber sheet-pile groins will be constructed that are 450 feet long. The groins will be constructed after the sand berm is constructed

The outlet works for the marsh will be placed through a cross-shore sand dike at the north end of the project extending from the tip of Deepwater Point to the offshore dike. The elevation of the crest of the cross-shore dike will be +8 feet MLW which is sufficient to prevent even the annual highest high-tide from overtopping the dike. This elevation also provides sufficient freeboard so that water levels in the site can be held high if needed. The cross-shore dike does not need additional elevation to prevent wave overtopping because it is protected from waves by the offshore dike. A geotextile tube like the one described for the offshore sand dike will be placed in the core of the cross-shore dike. The flows through the outlet works during dredging depend mainly on the depth of water above the weir crests.

The outlet works will have outflow pipes that pass through the core of the cross-shore dike. The cross-section of the cross-shore dike will be held to a minimum to minimize the length of outlet pipe required. The actual crest width of the dike will depend on the stability of the foundation upon which the dike is built. The dike will be filled until a stable cross-section is achieved. The dike will be constructed by moving sand from the

offshore dike with heavy equipment so that steeper side slopes can be achieved which will minimize the dike cross-section.

The outlet works provided at the north end of the project will control release of water during dredging. Several drop inlets are planned. The capacity of the outlet works will depend on the size of the dredge pump and discharge line, the frequency of hopper discharges (cycle time), and water control requirements for post-construction marsh management. But the potential to release water at a rate as high as 75-100 cfs may be required.

An outlet works at the southern end of the project will not be necessary for dredging purposes. However, tidal connection to the southern end of the site may be desired after the marsh develops and natural flow patterns emerge. Any additional tidal connection will be achieved, for example, through small tidal guts through the existing marsh to the Mahon River and not through the offshore dike. A tidal gut presently exists near the south end of the project and may provide an ideal connection with the Mahon River.

Further description and need for the Kelly Island wetland restoration can be found in Section 3.3.3.2 of the 1997 SEIS.

2.2.2 BROADKILL BEACH (DELAWARE)

The Federally authorized storm damage reduction and erosion control project along the community of Broadkill Beach is shown in Figure 4. The Delaware Bay Coastline, DE & NJ - Broadkill Beach, DE project was authorized for construction by Title I, Section 101 (a) (11) of the Water Resources Development Act of 1999. The Delaware Department of Natural Resources and Environmental Control is the non-Federal project sponsor. The project area is located along the Delaware Bay Coastline at Broadkill Beach, Sussex County, Delaware. The authorized plan for this project has the following components:

- A berm extending seaward 100 feet from the design line at an elevation of +8 ft NGVD. The beachfill extends from Alaska Avenue southward for 13,100 linear feet. Tapers of 1,000 feet extending from the northern project limit and 500 feet extending from the southern project limit brings the total project length to 14,600 linear feet.

- On top of the berm lies a dune with a top elevation of +16 ft NGVD and a top width of 25 feet.

- A total initial volume of 1,598,700 cubic yards of sand fill would be placed along the area. This fill volume includes initial design fill requirements and advanced nourishment.

- Periodic nourishment of 358,400 cubic yards of sand fill would be placed every 5 years.

- Planting of 174,800 square yards of dune grass and 21,800

linear feet of sand fence are included for dune stability.

- Vehicular access to the beach would be provided at Route 16 in the center of Broadkill Beach. Sand fence would be used to create a path 12 feet wide along both sides of the dune at a skewed angle to the dune alignment. This would allow vehicles to climb along the side of the dune at a flatter slope than 5H:1V.

- Pedestrian access paths would be located at each street end in a similar fashion as the vehicular access. However, the access paths would be smaller in width and at a somewhat steeper slope.

For protection of the sandbar shark, the following measures will be implemented to allow construction between 1 May and 15 September:

A sand dike, 200 to 300 feet in length, will be constructed above mean high water (MHW) to contain dredged material that is pumped landward of it. The dike will be constructed using existing sand on the beach. The dike will be long enough that most dredged material will drop out on the beach and not return to the bay. As material is deposited the dike may be repositioned seaward to contain the required tilling above MHW for that section of Beach. The slurry will still be controlled by the dike along the shoreline. No dredged material will be hydraulically placed below MHW during the restricted period. The dike will be extended down the beach as the area behind the dike is tilled and the dredged pipe is lengthened. The dredged material that has been deposited will be built into dunes. It is expected that little of this material will be re-deposited by wave action during the spring/summer window period since weather is generally mild, except for possible hurricanes. After September 15, some dredged material will be graded into the bay to widen the beach. Beach grading will be done by bull dowser and is expected to take six months to complete.

The dredged pipe will be placed on pontoons for a minimum of 1000 feet, beginning at approximately elevation -4.7 NGVD, extending offshore to avoid disrupting along shore traveling by the young sandbar sharks. This distance will be determined by the National Marine Fisheries Service. The remainder of the pipeline extending to the beach, and back to the dredge, can rest on the bottom.

Due to the fact that this site is already an authorized project, placing sand from the deepening project along Broadkill Beach will yield additional benefits to offshore benthic communities. Any sand acquired from the deepening project will reduce the amount of material needed from an offshore sand borrow source to complete the project template. In addition, economic benefits would also be realized due to cost savings resulting from jointly developing the deepening and Broadkill projects

rather than developing them independently.

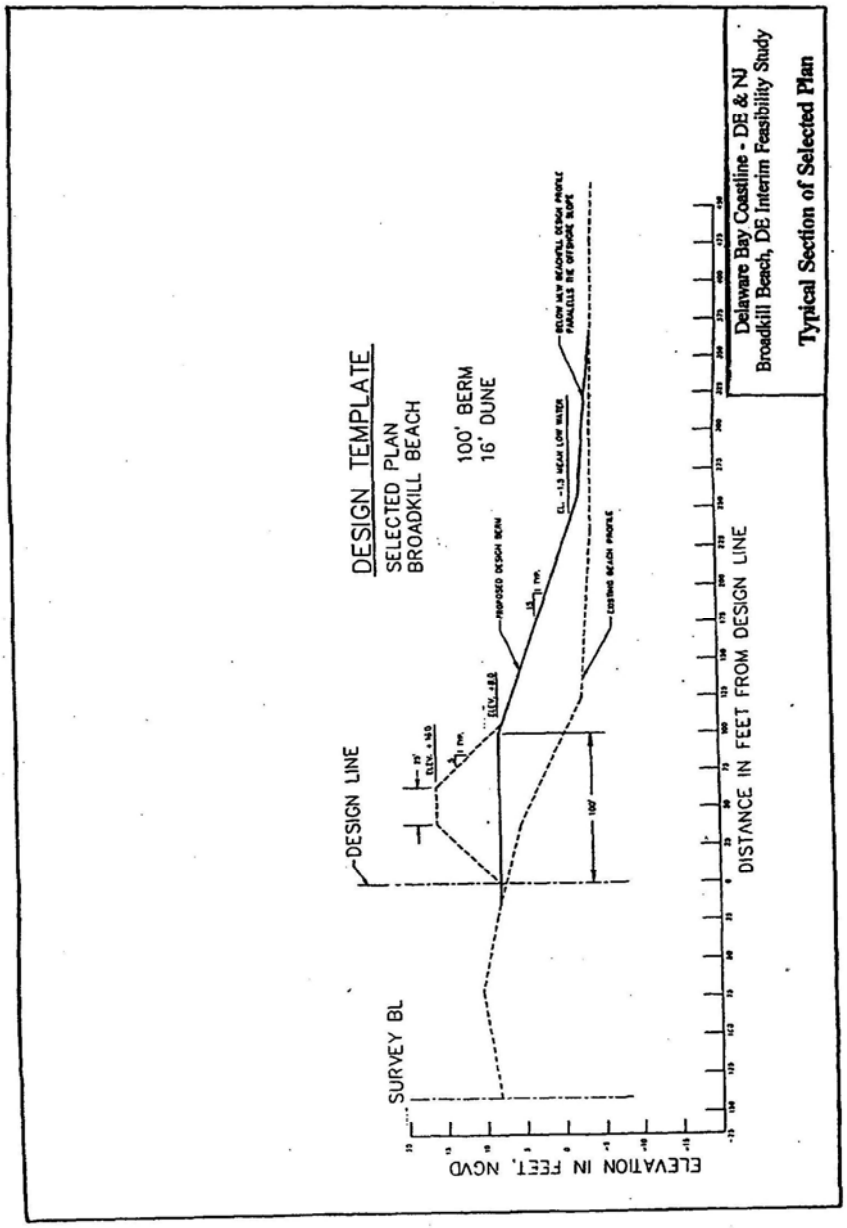

Figure 4. Broadkill Beach Design Template.

2.3 OPERATION AND MAINTENANCE

The required maintenance dredging of the 45-foot channel will increase by 862,000 cubic yards per year (cy/yr) from the current 3,455,000 average cy/yr for the 40-foot channel for a total of 4,317,000 cy/yr. Only areas shallower than 45 feet will be dredged during maintenance activities. Maintenance dredging in the river usually takes place over an approximately 2 month period between August and December using a hydraulic cutterhead dredge. All material excavated from the river portion of the project will continue to be placed in existing approved upland disposal areas. The timing and duration of maintenance dredging in the bay varies. Dredging in this area is done using a hopper dredge with open water disposal. Maintenance dredging is expected to be conducted yearly on an as needed basis for the 50 year project life.

2.4 CONSTRUCTION SCHEDULE

Figure 5 shows the construction schedule and the type of dredge that would be used for different sections of the river for the Deepening Project. The dredging plan was developed to be in compliance with the Delaware River Basin Fish and Wildlife Management Cooperative recommended dredging restrictions for protection of fishery resources in the Delaware River and Bay. Time periods shaded grey are the recommended periods for hopper dredging, cutterhead pipeline dredging, bucket dredging, sand placement and blasting. All dredging windows will be met in Reaches AA, A, B, C, D, and E above River Mile 32. Dredging below River Mile 32 and shoreline work at Kelly Island and Broadkill Beach can not be completed within the recommended windows. The only period of time that meets all recommended restrictions for these areas is the first half of the month of April. In order to minimize impacts for this work, the Corps coordinated with DNREC to develop an acceptable dredging schedule. In order to avoid impacting blue crabs, dredging below River Mile 32 will take place between April and July, followed by sand placement. This schedule does have the potential to impact Atlantic sturgeon during dredging activities taking place in June and July. These impacts are expected to be minimal and will be monitored by the endangered species monitor that will be onboard during these months. The potential also exists to impact horseshoe crabs during sand placement activities between mid-April and July. Due to the fact that neither Kelly Island nor Broadkill Beach are significant horseshoe crab spawning areas however, impacts to this species are expected to be minimal. In addition, following construction, it is anticipated that these sites will provide better horseshoe crab habitat.

2.5 PROJECT SPONSOR

Philadelphia Regional Port Authority (PRPA)

DREDGING CONTRACTS	River Mile	Duration (Mo)	Estimated Quantity (cy)	Dredge	
Contract No. 1 (award year 1)					hyd
Reach C- Bulkhead Bar					HYD
183+000 to 206+201 - Killicohook	68.3	1.65	932,600	1	
206+201 to 225+000 - Reedy Pt South	63.9	2.76	597,800	1	
225+000 to 242+514 - Killicohook	60.3	1.38	972,400	1	
			2,502,800		
Contract No. 2 (award year 2)					
Reach D- Reedy Pt. South		1.13	**396,300**	1	HOP
249+000 to 270+000	55.8				
					hop
Contract No. 3 (award year 2)					bla
Reach B - Rock Blasting		3.17		1	BLA
Reach B - Rock Dredging - Fort Mifflin		1.27		1	MEC
			77,000		
					mec
Contract No. 4 (award year 3)					hop
Reach E - Broadkill Beach - Dredge		3	**1,598,700**	2	HOP
461+300 to 512+000	15.6				
Construct Project					
					hyd
Contract No. 5 (award year 3)					hyd
Reach B - Oldmans		0.89	1,671,400	1	HYD
Reach B - Pedricktown North		3.51	1,050,700	1	HYD
Reach B - Pedricktown South		3.13	1,942,800	1	HYD
90+000 to 176+000	85.9				
			4,664,900		
Contract No. 6 (award year 4)					
Reach E - Kelly Island -Dredge		4.5		2	HOP
351+300 to 360+000	36.4		345,800		
360+000 to 381+000	32.1		55,500		
381+000 to 461+300	30.8		2,081,700		
Construct Project					
			2,483,000		hop
Contract No. 7 (award year 5)					hop
Reach D - Artificial Island	51.8	4.63	**1,654,800**	1	HOP
270+000 to 324+000					
Contract No. 8 (award year 5)					hyd
Reach AA - National Park		2.88	994,000	1	HYD
19+700 to 32+756	99.2				
Reach A - Pedricktown North		6.1	1,666,600	1	HOP
32+756 to 90+000	96.8				
			2,660,600		hop
		40	15,961,100		

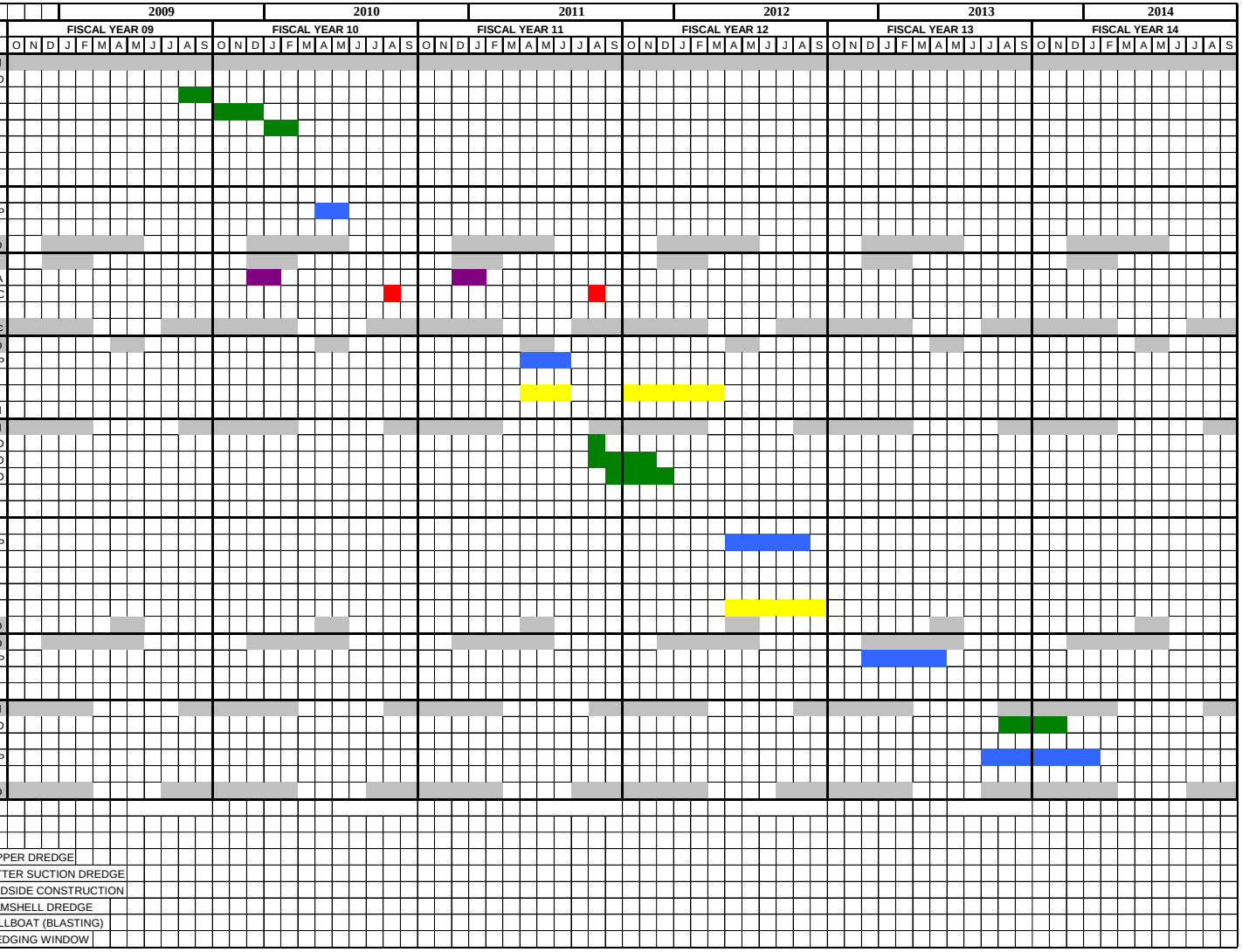

Figure 5. Proposed construction schedule for the Delaware River deepening project

2.6 DREDGING EQUIPMENT AND METHODS

To deepen navigation channels dredging is required. A variety of dredge types and techniques are employed on a project specific basis, dependent upon the characteristics of the channel, availability of disposal, local environmental regulations, types of material to be removed, and proposed timing of the dredging. In the Philadelphia District three types of dredges (hopper, bucket, and cutterhead pipeline) are commonly used.

The main channel deepening project will primarily use pipeline, hopper, and clamshell dredging techniques. Blasting to remove rock outcrops located in the Marcus Hook, Chester, Eddystone and Tinicum ranges will also be required.

Typically, the USACE does not specify the type of equipment that a contractor must use to dredge a channel. Each type of dredging equipment has different strengths and weaknesses. Some jobs can be accomplished by any type of dredge; other projects require specialized equipment. Many times, one type of equipment will be more efficient than another. In these cases the bidding process usually results in the more efficient plant and equipment being used to accomplish the required dredging. Discussion of the different types of dredging equipment that might be suitable for Delaware River deepening is provided below.

2.6.1 Self-Propelled Hopper Dredges

Hopper dredges are typically self-propelled seagoing vessels. They are equipped with propulsion machinery, sediment containers (i.e., hoppers), dredge pumps, and other specialized equipment required to perform their essential function of excavating sediments from the channel bottom. Hopper dredges have propulsion power adequate for required free-running speed and dredging against strong currents, and have excellent maneuverability. This allows hopper dredges to provide a safe working environment for crew and equipment to dredge bar channels or other areas subject to rough seas. This maneuverability also allows for safely dredging channels where interference with vessel traffic must be minimized.

A hopper dredge removes material from the bottom of the channel in thin layers, usually 2-12 inches, depending on the density and cohesiveness of the dredged material (Taylor, 1990). Pumps within the hull, but sometimes mounted on the dragarm, create a region of low pressure around the dragheads. This forces water and sediment up the dragarm and into the hopper. The more closely the draghead is maintained in contact with the sediment, the more efficient the dredging (i.e., the greater the concentration of sediment pumped into the hopper). Hopper dredges are most efficient for noncohesive sands and silts, and low density clay. Hopper dredges are not as efficient with medium to high density clays, or with dense sediments containing

a significant clay fraction.

In the hopper, the slurry mixture of sediment and water is managed to settle out the dredged material solids and overflow the supernatant water. When an efficient load is achieved, the vessel suspends dredging, the dragarms are heaved aboard, and the dredge travels to the placement site. Because dredging stops during the trip to the placement site, the overall efficiency of a hopper dredge is dependant on the distance between the dredging and placement sites (i.e., the more distant the placement site, the less efficient the hopper dredge).

2.6.2 Bucket Dredges

The bucket dredge is a mechanical device that utilizes a bucket to excavate the material to be dredged. The dredged material is placed in scows or hopper barges that are towed or pushed to the placement site. Bucket dredges include the clamshell, orange-peel, and dragline types, and can sometimes be interchanged to suit requirements. The crane that operates the bucket can be mounted on a flat-bottomed barge, on fixed-shore installations, or on a crawler mount. In most cases, spuds, or anchors and spuds are used to position the plant.

Bucket dredges are effective working near bridges, docks, wharves, pipelines, piers and/or breakwater structures because they do not require much area to maneuver (McLellan, et al., 1989). But, because they are not quickly or easily maneuvered, they are not well suited for dredging high traffic areas. Bucket dredges are very efficient in dredging silts and hard clays, and are better than any other dredge type for excavating areas where debris may be present. However, bucket dredges can have difficulty excavating sands. Because the bucket dredge loads scows or hopper barges, work is only suspended when a fully loaded barge is moved away and replaced with another empty scow or barge. As distance increases between the dredging site and the site for placement of the dredged material, more tugs and scows/barges can be added to the rotation. Because dredging can continue while the dredged material is being transported to the site, bucket dredge efficiency is not affected by haul distance, provided that a sufficient number of tugs and scows can be employed on the project.

Spuds are typically employed to maintain the position of a floating bucket dredge plant. The spuds can be raised and lowered as needed. However, the spuds and anchors cannot hold a floating plant in position in strong currents or exposed areas with high waves or ocean swells. Further, the typical floating plant for clamshell dredges would be unsafe for workers and equipment in rough seas when the barge is pitching and/or rolling, or with decks awash.

2.6.3. Hydraulic Cutterhead Pipeline Dredges

A cutterhead pipeline dredge is the most commonly used dredging plant in the United States. The cutterhead dredge is suitable for maintaining harbors, canals, and outlet channels, where wave heights are not excessive and suitable placement areas are nearby. It is essentially a barge hull with a moveable rotating cutter apparatus surrounding the intake of a suction pipe (Taylor, 1990). By combining the mechanical cutting action with the hydraulic suction, the hydraulic cutterhead has the capability of efficiently dredging a wide range of material, including clay, silt, sand, and gravel.

The largest hydraulic cutterhead dredges have 30 to 42 inch diameter pumps with 15,000 to 20,000 horsepower. These dredges are capable of pumping certain types of material through as much as 5-6 miles of pipeline, though up to 3 miles is more typical.

The attached pipeline also limits the maneuverability of the dredge. In addition, the cutterhead pipeline plant employs spuds and anchors in a manor similar to floating clamshell dredges. Accordingly, as with floating clamshell dredge plants, the hydraulic cutterhead should not be used in high traffic areas, and cannot be safely employed in rough seas. Cutterhead dredges are normally limited to operating in protected waterways where wave heights do not exceed 3 ft.

2.7 Rock Blasting

Approximately 77,000 cubic yards of bedrock from the Delaware River near Marcus Hook, PA (River Mile 76.4 to River Mile 84.6) would be removed to deepen the navigation channel to a depth of 47 ft below mean lower low water. Rock will be placed in the Fort Mifflin dredged material disposal site located in Philadelphia, PA (Figure 1). In order to remove the rock by blasting, holes drilled into the rock are packed with explosive and inert stemming material at the surface in order to direct the force of the blast into the rock. The depth and placement of the holes along with the size and blast timing delays of the charges control the amount of rock that is broken and energy levels released during the blasting operations. The project would be conducted by repeatedly drilling, blasting, and excavating relatively small areas until the required cross section of bedrock is removed. There have been no changes to the rock blasting portion of the project since the issuance of the 2001 Biological Opinion regarding blasting impacts to sturgeon.

3.0 SPECIES OF CONCERN

Listed species that may occur within Delaware River Deepening project area include loggerhead (*Caretta caretta*), Kemp's ridley (*Lepidochelys kempi*), green (*Chelonia mydas*), leatherback (*Dermochelys coriacea*), and hawksbill (*Eretmochelys imbricata*) sea turtles; and the right(*Eubalaena glacialis*), humpback (*Megaptera novaeangliae*), and fin (*Balaenoptera physalus*) whales. The shortnose sturgeon (*Acipenser brevirostrum*)

is also known to inhabit the Delaware River and bay. All of these species are endangered, except for the loggerhead sea turtle, which is threatened.

3.1 GENERAL SEA TURTLE INFORMATION

Living sea turtles are taxonomically represented by two families, five genera, and seven species (Hopkins and Richardson 1984, Carr 1952). The family Cheloniidae is comprised of five genera and six distinct species. These species are *Caretta caretta* (loggerhead), *Chelonia mydas* (green turtle), *C. depressa* (flatback), *Eretmochelys imbricata* (hawksbill), *Lepidochelys kempi* (Kemp's ridley), and *L. olivacea* (olive ridley). The family Dermochelidae is comprised of only one genus and species, *Dermochelys coriacea*, commonly referred to as the leatherback sea turtle.

Sea turtles are believed to be descended from species known from the late Jurassic and Cretaceous periods that were included in the extinct family Thallassemyidae (Carr 1952, Hopkins and Richardson 1984). Modern sea turtles have short, thick, incompletely retractile necks, and legs which have been modified to become flippers (Bustard 1972, Carr 1952). All species, except the leatherback have a hard, bony carapace modified for marine existence by streamlining and weight reduction (Bustard 1972).

The leatherback has smooth scaleless black skin and a soft carapace with seven longitudinal keels (Carr 1952). These differences in structure are the principal reason for their designation as the only species in the monotypic family Dermochelidae (Carr 1952).

Sea turtles spend most of their lives in an aquatic environment, and males of many species may never leave the water (Hopkins and Richardson 1984, Nelson 1988). The recognized life stages for these turtles are egg, hatchling, juvenile/subadult, and adult (Hirth 1971).

Reproductive cycles in adults of all species involve some degree of migration in which the animals return to nest at the same beach year after year (Hopkins and Richardson 1984).Nesting generally begins about the middle of April and continues into September (Hopkins and Richardson 1984, Nelson 1988, Carr 1952). Mating and copulation occur just off the nesting beach. A nesting female moved shoreward by the surf lands on the beach, and if suitable crawls to a point above the high water mark (Carr 1952). She then proceeds to excavate a shallow body pit by twisting her body in the sand (Bustard 1972). After digging the body pit she proceeds to lay her eggs, size and egg shape is species specific (Bustard 1972). Incubation periods for loggerheads and green turtles average 55 days, but range from 45 to 65 days depending on local conditions (Nelson 1988).

Hatchlings emerge from the nest at night, breaking the egg shell and digging their way out of the nest (Carr 1952). They find their way across the beach to the surf by orienting to light reflecting off the breaking surf (Hopkins and Richardson 1984). Once in the surf, hatchlings exhibit behavior known as "swim frenzy," during which they swim in a straight line for many hours (Carr 1986). Once into the waters off the nesting beach, hatchlings enter a period known as the "lost year". It is not known where this time is spent, what habitat this age prefers, or mortality rates during this period. It is currently believed the period encompassed by the "lost year" may actually turn out to be several years. Various hypothesis have been put forth about the "lost year." One is that hatchlings may become associated with floating sargassum rafts offshore. These rafts provide shelter and are dispersed randomly by the currents (Carr 1986). Another hypothesis is that the "lost year" for some species may be spent in a salt marsh/estuarine system (Garmon 1981).

The functional ecology of sea turtles in the marine and/or estuarine ecosystem is varied. The loggerhead is primarily carnivorous and has jaws well-adapted to crushing mollusks and crustaceans, and grazing on encrusted organisms attached to reefs, pilings and wrecks. The Kemp's ridley is omnivorous and feeds on swimming crabs and crustaceans. The green turtle is a herbivore and grazes on marine grasses and algae while the leatherback is a specialized feeder preying primarily upon jellyfish. Until recently, sea turtle populations were large and subsequently played a significant role in the marine ecosystem. This role has been greatly reduced in most locations as a result or declining turtle populations. These population declines are a result of natural factors such as disease and predation, habitat loss, commercial overutilization, and inadequate regulatory mechanisms for their protection. This has led to several species being in danger, or threatened with extinction.

However, due to changes in habitat use during different life history stages and seasons, sea turtle populations are difficult to census (Meylan 1982). Because of these problems, estimates of population numbers have been derived from various indices such as numbers of nesting females, numbers of hatchlings per kilometer of nesting beach, and number of subadult carcasses (strandings) washed ashore (Hopkins and Richardson 1984).

3.2 LOGGERHEAD (*Caretta caretta*)

3.2.1 DESCRIPTION

The adult loggerhead turtle has a slightly elongated, heart-shaped carapace that tapers towards the posterior, and has a broad triangular head (Pritchard et al. 1983). Loggerheads normally weigh up to 450 pounds (200 kilograms), and attain a carapace length (straight line) up to 48 inches (120 centimeters)

(Pritchard et al. 1983). Their general coloration is reddish-brown dorsally and cream-yellow ventrally (Hopkins and Richardson 1984). Morphologically, the loggerhead is distinguishable from other sea turtle species by the following characteristics: 1) a hard shell; 2) two pairs of scutes on the front of the head, 3) five pairs of lateral scales on the carapace; 4) plastron with three pairs of enlarged scutes connecting the carapace; 5) two claws on each flipper; and, 6) reddish-brown coloration (Nelson 1988, Dodd 1988, Wolke and George 1981).

3.2.2 DISTRIBUTION

Loggerhead turtles inhabit continental shelves, bays, lagoons, and estuaries in the temperate, subtropical and tropical waters of the Atlantic, Pacific and Indian Oceans (Dodd 1988, Mager 1985). In the western Atlantic Ocean, loggerhead turtles occur from Argentina northward to Nova Scotia, including the Gulf of Mexico and the Caribbean Sea (Carr 1952, Dodd 1988, Mager 1985, Nelson 1988). Sporadic nesting is reported throughout the tropical and warmer temperate range of distribution, but the most important nesting areas are the Atlantic coast of Florida, Georgia and South Carolina (Hopkins and Richardson 1984). The Florida nesting population of loggerheads has been estimated to be the second largest in the world (Ross 1982).

The foraging range of the loggerhead sea turtle extends throughout the warm waters of the U.S. continental shelf (Shoop et al. 1981). On a seasonal basis, loggerhead turtles are common as far north as the Canadian portions of the Gulf of Maine (Lazell 1980), but during cooler months of the year, distributions shift to the south (Shoop et al. 1981). Loggerheads frequently forage around coral reefs, rocky places and old boat wrecks; they commonly enter bays, lagoons and estuaries (Dodd 1988). Aerial surveys of loggerhead turtles at sea indicate that they are most common in waters less than 50-meters in depth (Shoop et al. 1981), but they occur pelagically as well (Carr 1986).

3.2.3 FOOD

Loggerheads are primarily carnivorous (Mortimer 1982). They eat a variety or benthic organisms including mollusks, crabs, shrimp, jellyfish, sea urchins, sponges, squids, and fishes (Nelson 1988). Adult loggerheads have been observed feeding in reef and hard bottom areas (Mortimer 1982). In seagrass areas of Mosquito Lagoon, Florida, subadult loggerheads feed almost exclusively on horseshoe crabs (Mendonca and Ehrhart 1982). Loggerheads may also eat animals discarded by commercial trawlers (Shoop and Ruckdeschel 1982). This benthic feeding characteristic may contribute to the capture of these turtles in trawls.

3.2.4 NESTING

The nesting season of the loggerhead is confined to the warmer months of the year in the temperate zones of the northern hemisphere. In south Florida nesting may occur from April through September, but usually peaks in late June and July (Dodd 1988, Florida Power & Light Company 1983).

Loggerhead females generally nest every other year or every third year (Hopkins and Richardson 1984). When a loggerhead nests, it usually will lay 2 to 3 clutches of eggs per season, and will lay 35 to 180 eggs per clutch (Hopkins and Richardson 1984). The eggs hatch in 46 to 65 days and hatchlings emerge 2 or 3 days later (Hopkins and Richardson 1984).

Hatchling loggerheads are a little less than 2 inches (5 centimeters) in length when they emerge from the nest (Hopkins and Richardson 1984, Florida Power & Light Company 1983). They emerge from the nest as a group at night, orient themselves seaward, and rapidly move towards the water (Richardson 1984). Many hatchlings fall prey to sea birds and other predators following emergence. Those hatchlings that reach the water quickly move offshore and exist pelagically (Carr 1986).

3.2.5 POPULATION SIZE

Loggerhead sea turtles are the most common sea turtle in the coastal waters of the United States. Based on numbers of nesting females, numbers of hatchlings per kilometer of nesting beach, and number or subadult carcasses (strandings) washed ashore, the total number of mature loggerhead females in the southeastern United States has been estimated to be from 35,375 to 72,520 (Hopkins and Richardson 1984; Gordon 1983).

Adult and sub-adult (shell length greater than 60 centimeters) population estimates have also been based on aerial surveys of pelagic animals observed by NMFS during 1982 to 1984. Based on these studies, the current estimated number or adult and sub-adult loggerhead sea turtles from Cape Hatteras, North Carolina to Key West, Florida is 387,594 (NMFS 1991). This number was arrived at by taking the number of observed turtles and converting it to a population abundance estimate using information on the amount of time loggerheads typically spend at the surface.

Some sea turtles which die at sea wash ashore and are found stranded. The NMFS, Sea Turtle Salvage and Stranding Network collects stranded sea turtles along both the Atlantic and Gulf Coasts. Based on 1987 data, over 2,300 loggerhead turtles were reported by the network. The largest portion was collected from the southeast Atlantic Coast (1,414 turtles), followed by the Gulf Coast (593 turtles), and the northeast Atlantic coast (347 turtles).

Onboard observation of offshore shrimp trawling by NMFS in the southeast Atlantic in 1987 estimated that over 43,000 loggerheads are captured in shrimp trawls annually. The number

of loggerhead mortalities from this activity was estimated to be 9,874 turtles annually.

Based on these data, it is evident that a large population of loggerhead sea turtles exists in the southeast Atlantic and Gulf of Mexico. Various population estimates suggest that the number of adult and sub-adult turtles is probably in the hundreds of thousands in the southeastern United States alone. This plus the fact that other populations of loggerheads occur in many other parts or the world suggest that although this species needs to be conserved, it is not in any immediate danger of becoming endangered. However, the continued development of coastal foraging areas, and population mortalities due to offshore trawling, is likely to have a negative impact on population size. In fact, one researcher has suggested that loggerhead turtle nesting populations in the U.S. has been declining (Frazer 1986).

World Wildlife Federation estimates that current 2008 population size of loggerheads as being 60,000 nesting females.

3.3 KEMPS RIDLEY (*Lepidochelys kempi*)

3.3.1 DESCRIPTION

The adult Kemp's ridley has a circular-shaped carapace and a medium sized pointed head (Pritchard et al. 1983). Ridleys normally weigh up to 90 pounds (42 kilograms) and attain a carapace length (straight line) up to 27 inches (70 centimeters) (Pritchard et al. 1983). Their general coloration is olive-green dorsally and yellow ventrally (Hopkins and Richardson 1984). Morphologically, the Kemp's ridley is distinguishable from other sea turtle species by the following characteristics: 1) a hard shell; 2) two pairs of scutes on the front of the head, 3) five pairs of lateral scutes on the carapace; 4) plastron with four pairs of scutes, with pores connecting the carapace; 5) one claw on each front flipper and two on each back flipper; and 6) olive-green coloration (Pritchard et al. 1983, Pritchard and Marquez 1973).

Kemp's ridley hatchlings are dark grey-black above and white below (Pritchard et al. 1983, Pritchard and Marquez 1973).

3.3.2 DISTRIBUTION

Kemp's ridley turtles inhabit sheltered coastal areas and frequent larger estuaries, bays and lagoons in the temperate, subtropical and tropical waters of the Atlantic Ocean and Gulf of Mexico (Mager 1985).

The foraging range of the adult Kemp's ridley sea turtle appears to be restricted to the Gulf of Mexico. However, juveniles and subadults occur throughout the warm coastal waters of the U.S. Atlantic coast (Hopkins and Richardson 1984, Pritchard and Marquez 1973). On a seasonal basis, ridleys are

common as far north as the Canadian portions of the Gulf of Maine (Lazell 1980), but during cooler months of the year they shift to the south (Morreale et al. 1988).

3.3.3 FOOD

Kemp's ridleys are omnivorous and feed on crustaceans, swimming crabs, fish, jellyfish and mollusks (Pritchard and Marquez 1973).

3.3.4 NESTING

Kemp's ridley nesting is mainly restricted to a stretch of beach near Rancho Nuevo, Tamaulipas, Mexico (Pritchard and Marquez 1973, Hopkins and Richardson 1984). Occasional nesting has been reported on Padre Island, Texas and Veracruz, Mexico (Mager 1985).

The nesting season of the Kemp's ridley is confined to the warmer months of the year primarily from April through July. Kemp's ridley females generally nest every other year or every third year (Pritchard et al. 1983). They will lay 2 to 3 clutches of eggs per season, and will lay 50 to 185 eggs per clutch (Hopkins and Richardson 1984). The eggs hatch in 45 to 70 days and hatchlings emerge 2 or 3 days later (Hopkins and Richardson 1984).

Hatchling ridleys are a little less than 2 inches (4.2 centimeters) in length when they emerge from the nest (Hopkins and Richardson 1984). They emerge from the nest as a group at night, orient themselves seaward, and rapidly move towards the water (Hopkins and Richardson 1984). Following emergence, many hatchlings fall prey to sea birds, raccoons and crabs. Those hatchlings that reach the water quickly move offshore. Their existence after emerging is not well understood but is probably pelagic (Carr 1986).

3.3.5 POPULATION SIZE

Kemp's ridley sea turtles are the most endangered of the sea turtle species. There is only a single known colony of this species, almost all of which nest near Rancho Nuevo, Tamaulipas, Mexico. An estimated 40,000 females nested on a single day in 1947, but since 1978 there have been less than 1,000 nests per season. Based on nesting information from Rancho Nuevo, it appears that the population is declining at a rate of approximately 3 percent per year (Ross, 1989). Also, based on the numbers of nests produced at Rancho Nuevo, the species nesting cycle, male-female ratios, and fecundity, the adult Kemp's ridley population has been estimated to be approximately 2,200 adults (Marquez 1989).

Kemp's ridleys also die at sea and wash ashore. The NMFS, Sea Turtle Salvage and Stranding Network collects stranded sea turtles along both the Atlantic and Gulf Coasts. Based on 1987

data, 767 ridleys were reported by the network. The largest portion was collected from the Gulf Coast (103 turtles), and mostly the western portion of the Gulf. Nearly equal numbers of ridleys were reported from the northeast and southeast Atlantic Coasts (64 and 50, respectively).

Onboard observation of offshore shrimp trawling by NMFS in the southeast Atlantic indicated that over 2,800 ridleys are captured in shrimp trawls annually. The estimated number of ridley mortalities from this activity was estimated to be 767 turtles annually, and most of these (65 percent) occurred in the western portion of the Gulf of Mexico.

World Wildlife Federation estimates that current 2008 population size of Kemp's ridleys as being 1,000 nesting females. Based on these data it is evident that the population is in danger of extinction.

3.4 GREEN TURTLE (*Chelonia mydas*)

3.4.1 DESCRIPTION

The green turtle is a medium to large sea turtle with a nearly oval carapace and a small rounded head (Pritchard et al. 1983). The carapace is smooth and olive-brown in color with darker streaks and spots. Its plastron is yellow. Greens normally weigh up to 220 pounds (100 kilograms), and attain a carapace length (straight line) up to 35 inches (90 centimeters) (Pritchard et al. 1983, Hopkins and Richardson 1984).

Morphologically this species can be distinguished from the other sea turtles by the following characteristics: 1) a relatively smooth shell with no overlapping scutes; 2) one pair of scutes on the front of the head, 3) four pairs of lateral scutes on the carapace; 4) plastron with four pairs of enlarged scutes connecting the carapace; 5) one claw on each flipper; and 6) olive, dark-brown mottled coloration (Nelson 1988, Pritchard et al. 1983, Carr 1952).

3.4.2 DISTRIBUTION

Green turtles are circumglobally distributed mainly in waters between the northern and southern 20° C isotherm (Mager 1985). In the western Atlantic, several major assemblages have been identified and studied (Parsons 1962, Pritchard 1969, Schulz 1975, Carr et al. 1978). In the continental U.S. however, the only known green turtle nesting occurs on the Atlantic coast of Florida (Mager 1985).

3.4.3 FOOD

Green sea turtles are primarily herbivores, eating sea grasses and algae. Other organisms living on sea grass blades and algae add to the diet (Mager 1985, Burke et al. 1992).

3.4.4 NESTING

Green turtle nesting occurs on the Atlantic coast of Florida from June to September (Hopkins and Richardson 1984). Mature females may nest three to seven times per season at about 10 to 18 day intervals. Average clutch sizes vary between 100 and 200 eggs that hatch usually within 45 to 60 days (Hopkins and Richardson 1984). Hatchlings emerge, mostly at night, travel quickly to the water, and swim out to sea. At this point, they enter a period which is poorly understood but is likely spent pelagically in areas where currents concentrate debris and floating vegetation such as sargassum (Carr 1986).

3.4.5 POPULATION SIZE

The number of green sea turtles that existed before commercial exploitation and the total number that now exist are not known. Records show drastic declines in the Florida catch during the 1800's, and similar declines occurred in other areas (Hopkins and Richardson 1984).

The decline and elimination of many nesting beaches, and less frequent encounters with green turtles provide inferential evidence that stocks are generally declining (Mayer 1985, Hopkins and Richardson 1984). World Wildlife Federation estimates that current 2008 population size of Green turtles as being 203,000 nesting females.

3.5 LEATHERBACK TURTLE (*Dermochelys coriacea*)

3.5.1 DESCRIPTION

The leatherback turtle is the largest of the sea turtles. It has an elongated, somewhat triangularly shaped body with longitudinal ridges or keels. It has a leathery blue-black shell composed of a thick layer of oily, vascularized cartilaginous material, strengthened by a mosaic of thousands of small bones. This blue-black shell may also have variable white spotting (Pritchard et al. 1983). Its plastron is white. Leatherbacks normally weigh up to 660 pounds (300 kilograms), and attain a carapace length (straight line) of 55 inches (140 centimeters) (Pritchard et al. 1983, Hopkins and Richardson 1984). Specimens as large as 910 kilograms (2,000 pounds) have been observed.

Morphologically this species can be easily distinguished from the other sea turtles by the following characteristics: 1) its smooth unscaled carapace; 2) carapace with seven longitudinal ridges; 3) head and flippers covered with unscaled skin; and, 4) no claws on the flippers (Nelson 1988, Pritchard et al. 1983, Pritchard 1971, Carr 1952).

3.5.2 DISTRIBUTION

Leatherbacks have a circumglobal distribution and occur in the Atlantic, Indian and Pacific Oceans. They range as far north as Labrador and Alaska to as far south as Chile and the Cape of Good Hope. They are found farther north than other sea turtle species, probably because of their ability to maintain a warmer body temperature over a longer period of time.

3.5.3 FOOD

The diet or the leatherback consists primarily of sort-bodied animals such as jellyfish and tunicates, together with juvenile fishes, amphipods and other organisms (Hopkins and Richardson 1984).

3.5.4 NESTING

Leatherback turtle nesting occurs on the mid-Atlantic coast of Florida from March to September (Hopkins and Richardson 1984). Mature females may nest one to nine times per season at about 9 to 17 day intervals. Average clutch sizes vary between 50 and 170 eggs that hatch usually within 50 to 70 days (Hopkins and Richardson 1984). Hatchlings emerge, mostly at night, travel quickly to the water, and swim out to sea. The early history of the leatherback is poorly understood since juvenile turtles are rarely observed.

3.5.5 POPULATION SIZE

World population estimates for the leatherback have been revised upward to over 100,000 females in recent years, due the discovery of nesting beaches in Mexico (Pritchard 1983). World Wildlife Federation estimates that current 2008 population size of leatherback turtles as being 34,000 nesting females.

3.6 HAWKSBILL TURTLE (*Eretmochelys imbricata*)

3.6.1 DESCRIPTION

The sizes of adult hawksbill turtles vary significantly. Carapace lengths at maturity range from 65 to over 90 cm, and weights range from 35 to over 125 kg (Prichard, 1979, Witzell, 1983). The only hawksbill recorded in the Chesapeake Bay was a juvenile with carapace length of 31 cm and weight of 4.0 kg (Keinath et al. 1987). The dorsum of the carapace and appendages are a combination of amber, brown, and black. The plastron and venter of the appendages are yellow, often with dark brown or black spots in young individuals. The carapacial scutes overlap at the posterior edges, and the posterior margin of the carapace is distinctly serrated. There are four prefrontal and three pleural scutes. The cervical scute does not touch the pleural scutes (Carr, 1952; Musick, 1988).

3.6.2 DISTRIBUTION

Hawksbill sea turtles are rare in all portions of their range, and are relatively uncommon in the waters of the continental U.S. Adult hawksbill turtles do not travel beyond the tropics, although presumably lost young turtles are found at higher latitudes (Carr 1952; Pritchard, 1979). Small hawksbills have stranded as far north as Cape Cod, Massachusetts (STSSN database, 1990); but most of these strandings have been observed after hurricanes or offshore storms. Hawksbills typically inhabit coral reefs and rocky places, such as those found in the Caribbean and Central America (Ernst and Barbour, 1972; Pritchard, 1979; Witzell, 1983). However, there are accounts of hawksbills in south Florida, and a surprising number are encountered in Texas. Most of the Texas records are small turtles, probably in the 1-2 year class range. Many of these captures or strandings are of individuals in an unhealthy or injured condition (Hildebrand 1982). The lack of sponge-covered reefs, and the cold winters in the northern Gulf of Mexico probably prevent hawksbills from establishing a viable population in this area.

3.6.3 FOOD

Hawksbills were considered omnivorous (Carr, 1952; Ernst and Barbour, 1972), but recent evidence suggests that Hawkbills feed preferentially on sponges (Meylan, 1988). Hawksbills feed primarily on a wide variety of sponges but also consume bryozoans, coelenterates, and mollusks.

3.6.4 NESTING

Hawksbills nest on tropical islands and sparsely inhabited tropical continental shores around the world. Eastern Atlantic nesting records are from only a few African locations and associated offshore islands (Brongersma, 1982). Western Atlantic nesting records extend from Brazil to Florida's southern Atlantic coast, including the Caribbean and southwestern Gulf of Mexico. Although small nesting concentrations do exist (Antigue), nesting is generally distributed at low densities across much of the Caribbean and the waters of the United States. Nesting areas in western North America include Puerto Rico and the Virgin Islands.

3.6.5 POPULATION SIZE

Due to a small number of nests spread over a wide geographical area, remote inaccessible nesting beaches, and large year to year fluctuations in nesting counts, the hawksbill is an exceedingly difficult species to monitor for longterm trends. A survey of nests in Surinam has provided a series of 13 annual estimates over 15 years. The trend is positive, but the small number of turtles and the absence of recent data makes the trend questionable (NRC. 1990). Hawksbill turtles were considered endangered throughout their range by the U.S. Fish and Wildlife Service on June 2, 1970, and were listed as endangered in the ESA of 1973. World Wildlife Federation estimates that current 2008 population size of Hawksbill turtles as being 8,000 nesting

females.

3.7 GENERAL WHALE INFORMATION

A former resource of the Delaware Estuary, whales convinced Dutch settlers to establish their first permanent settlement in Delaware on Cape Henlopen, in 1631. Since then the numbers of whales off of the New Jersey and Delaware coast have decreased. Records indicate that the endangered humpback whales (*Megaptera novaeangliae*), fin whales (*Balaenoptera physalus*) and right whales (*Eubalaena glacialis*) were occasionally sighted in the Delaware Estuary. However, since the introduction of the Endangered Species Act in 1973, whales have been sighted with increasing frequency along the New Jersey and Delaware Coast, and have become the subject of a growing whale watch industry in the mid-Atlantic.

3.8 HUMPBACK WHALE (*Megaptera novaeangliae*)

3.8.1 STATUS

Although less common in Arctic regions, the humpback whale (*Megaptera novaeangliae*) occurs in all oceans of the world. The humpback whale was heavily exploited by commercial whalers until the middle of the century. In 1915, only a few hundred humpbacks were reported to remain in the northwest Atlantic (Sergeant, 1966). In 1955, the North Atlantic population received protection when the International Whaling Commission (IWC) placed a prohibition on non-subsistence hunting. The humpback was classified as an endangered species when the Endangered Species Act was passed in 1973, and it remains so today.

3.8.2 DESCRIPTION

The humpback whale usually attains a length of about 12 to 15 meters (40 to 50 feet). It is black, with a variable amount of white below, and is characterized by very long, narrow flippers, scalloped at the forward edge and by large knobs, each associated with one or two hairs on its head and jaws. The dorsal fin is small and set far back, and there are about twenty lengthwise grooves on the throat and chest.

Humpback whales are secondary and tertiary carnivores and have been described as generalists in their feeding habits (Mitchell, 1974). The principal prey of humpbacks in the Gulf of Maine are small schooling fishes including: Atlantic herring, mackerel, pollock, and the American sand eel or sand lance (Gaskin, 1982; Katona et al., 1983; Watkins and Schevill, 1979).

3.8.3 LIFE HISTORY AND DISTRIBUTION

Humpback whales are found throughout the oceans of the world, migrating from tropical and subtropical breeding grounds

in winter to temperate and arctic feeding grounds in summer (Evans, 1987). Several stocks occur in the northwestern Atlantic. Adults and newborns of the Gulf of Maine migrate from summer feeding grounds off the coast of New England to winter breeding grounds along the Antillean Chain of the West Indies, primarily on Silver Bank and Navidad Bank north of the Dominican Republic. Some individuals remain in the Gulf of Maine throughout the year.

Until recently, humpback whales in the mid-Atlantic were considered transients. Few were seen during aerial surveys conducted in the early 1980's (Shoop, et al., 1982). However, since 1989, sightings of feeding juvenile humpbacks have increased along the coast of Virginia, peaking in the months of January through March in 1991 and 1992 (Swingle, et al., 1993). Studies conducted by the Virginia Marine Science Museum indicate that the whales are feeding on, among other things, bay anchovies, and Atlantic menhaden. In concert with the increased sightings, strandings of whales have increased in the mid-Atlantic during this time, with 32 strandings reported between New Jersey and Florida since January 1989. Sixty percent of those that were closely investigated showed either signs of entanglement, or vessel collision (Wiley, et al., 1992).

3.8.4 POPULATION SIZE

The International Whaling Commission estimates the North Atlantic Humpback Whale population in the 1992/1993 period as being 11,600.

3.9 FIN WHALE (*Balaenoptera physalus*)

3.9.1 STATUS

The fin whale is considered one of the more abundant large whale species, with a worldwide population estimated at around 120,000. However, only a few thousand fin whales are believed to exist in the North Atlantic (Gambell, 1985). The fin whale was placed on the list of endangered species in 1973, and it remains so today.

3.9.2 DESCRIPTION

The fin (finback, razorback) whale is a slender whale which derives its name from the ridge on its back. The fin whale is a swift, streamlined whale 18 to 24 meters (60 to 80 feet) long. It has a triangular dorsal fin, flat head, a pair of blowholes, and 80 or more grooves along its throat and chest. It is gray with white on the underparts, and on the right side of the lower jaw.

3.9.3 LIFE HISTORY AND DISTRIBUTION

During the summer, in the eastern North Atlantic, fin whales

can be found along the North American coast to the Arctic and around Greenland. The wintering areas extend from the ice edge south to the Caribbean and the Gulf of Mexico.

Fin whales in the North Atlantic feed on fish: herring, cod, mackerel, pollock, sardines, and capelin, as well as squid, euphausiids, and copepods. Peak months for breeding in the North Atlantic are December and January. A single calf, averaging about six meters in length, is produced after a gestation period of a little more than 11 months. Fully mature females may reproduce every two to three years. In the Northern Hemisphere, females reach maturity at length of over 18 meters; males reach maturity at lengths slightly less than 18 m. Although fin whales are sometimes found singly, or in pairs, they commonly form larger groups of 3-20, which may in turn coalesce into a broadly spread concentration of a hundred or more individuals, especially in the feeding grounds (Gambell, 1985). The fin whale was a prime target for commercial whaling after the Norwegian development of the explosive harpoon in 1864. The number of whales in the North Atlantic was quickly depleted.

Fin whales are often spotted in mid-Atlantic waters. Some fin whales were seen off the Delmarva peninsula during aerial surveys conducted in the early 1980's (Shoop, et al., 1982). Since 1989, sightings of feeding juvenile fin whales have increased along the coast of Virginia in the same area as the humpback whales. Fin whales are more difficult to study due to their speed. However, it is believed that they are feeding with the humpback whales, on bay anchovies and menhaden.

3.9.4 POPULATION SIZE

The International Whaling Commission estimates the North Atlantic Fin Whale population in the 1996/2001 period as being 30,600.

3.10 RIGHT WHALE (*Eubalaena glacialis*)

3.10.1 STATUS

The northern right whale is the world's most endangered large whale. Current estimates place the total number of remaining animals at no more than 600 (NMFS 1991). Right whales have been protected from commercial whaling since 1949. The right whale was placed on the list of endangered species in 1973, and it remains so today.

3.10.2 DESCRIPTION

In North American waters these robust whales lack a dorsal fin and ventral grooves. The body is black with various white markings, comprising 28-33% of the body. The rostrum is narrow and highly arched, giving a distinct curvature to the top of the head. There are paired blow holes on the top of the head. The

baleen plates are long and narrow, with an anterior separation of the left and right row (Audubon 1983).

3.10.3 LIFE HISTORY AND DISTRIBUTION

The north Atlantic right whale is one of the most endangered large whales in the world. Right whales are often near shore in shallow water, and sometimes sighted in large bays. Populations concentrate in five known areas; coastal Florida and Georgia, the Great South Channel east of Cape Cod, Massachusetts, Cape Cod Bay and Massachusetts Bay, the Bay of Fundi, and Browns and Baccaro Banks south of Nova Scotia. The population appears to migrate seasonally.

In recent years, two to six northern right whales have been sighted each winter off Long Island and off of New Jersey Beaches. In February 1983, an animal stranded in New Jersey was identified as a two-year old northern right whale that had first been photographed in the Bay of Fundi in 1981 (NMFS 1991). It is now believed that a portion of the North Atlantic right whale population is migrating along the United States east coast each year from Iceland to Florida. There is growing evidence that calves are born when the whales are at the southern end of their migration, in the Atlantic off northeastern Florida, Georgia, and possibly the Carolinas.

3.10.4 POPULATION SIZE

The International Whaling Commission estimates the North Atlantic Right Whale population in the 2001 period as being only 300.

3.11 GENERAL SHORTNOSE STURGEON INFORMATION

The shortnose sturgeon (*Acipenser brevirostrum*) is an endangered species of fish found in major rivers of eastern North America, from the Saint John's River in Florida to the Saint John River in New Brunswick, Canada. This species may also be found in estuaries and in ocean regions adjacent to river mouths. Although typically an anadromous species, landlocked populations of shortnose sturgeon are known to exist. In September 1986 the Philadelphia District initiated formal consultation under Section 7 of the Endangered Species Act of 1977 (16 U.S. C. 1531 et seq.), with regard to maintenance dredging of the Delaware River Federal Navigation Projects from Trenton to the sea and potential impacts to the Federally endangered shortnose sturgeon (*Acipenser brevirostrum*).

3.11.1 DESCRIPTION

Shortnose sturgeon are large ancient fish with a cartilaginous skeleton, heterocercal tail, and spiral valve. Shortnose sturgeon within the Delaware River are considered anadromous fish. Shortnose sturgeon are easily recognized by the

short shovel-shaped snout, large fleshy barbels, ventrally located mouth, and large bony scutes (or plates) on the head and along the back and sides. They are dark brown to black on the upper side and light brown to yellow on the lower side. Adults are generally large fish (up to 43 inches in length), while the young are generally under 24 inches and have black or dusky blotches on snout and body.

Shortnose sturgeon spawn in freshwater, usually above tidal influence. In northern latitude river systems, spawning grounds are generally characterized by fast flows (40-60 cm/sec) and gravel or rubble bottoms. Spawning occurs in the spring. In the Delaware River, spawning normally occurs during the middle 2 weeks of April (Hoff, 1965; Brundage, 1982a).

Little is known about spawning behavior. The spawning population moves from the overwintering site to the spawning grounds together. Eggs are released immediately over the bottom substrate, which minimizes downstream transport (Washburn and Gillis Associates, Ltd., 1981). Eggs are separate when released, but become adhesive within 20 minutes of fertilization. Fertilization is probably external. The eggs are negatively buoyant, and rapidly attach to the bottom substrate.

Early growth is rapid, young-of-year obtain a length of 14-30 cm by the end of the first growing season. Rate of growth appears to be dependent upon latitude. Data collected from the Hudson River indicate that young-of-year may reach 25 cm by the end of the first growing season (Pekovitch, 1979).

Larvae and juveniles are primarily benthic. They normally remain in freshwater until maturity, and occupy deep channels with strong currents. During the early stages of development, larvae remain near the bottom and conceal themselves under available cover (Buckley and Kynard, 1981; Pottle and Dadswell, 1979).

Maturity for both males and females is reached at a length of 45 to 55 cm fork length. Males mature between the age of 3 and 5 years, while females mature between the age of 6 and 7 years. Initial spawning in males occurs 1 to 2 years after reaching maturity. In females, the initial spawn may occur 5 to 10 years after reaching maturity. Adults do not spawn every year.

3.11.2 GENERAL DISTRIBUTION

Shortnose sturgeon range from the Saint John River, New Brunswick, Canada, to the Saint John's River, Florida (Dadswell et al., 1984). Throughout its range, the shortnose sturgeon occurs in rivers, estuaries, and occasionally in the sea. Populations tend to be most abundant in, and upstream from the estuarine section of the inhabited river system. Shortnose sturgeon captures at sea have occurred only within a few miles of

land.

The seasonal distribution of shortnose sturgeon in northern latitudes has been described based on work by Dadswell (1979), Dovel (1981), and Squires and Smith (1979) in the Saint John, Hudson, and Kennebec rivers, respectively. The seasonal distribution of shortnose sturgeon in the Delaware River corresponds to this generalized pattern. Seasonal distribution appears to be dependent upon life stage, reproductive state, and latitude.

Sampling by O'Herron and Able in the Trenton - Roebling, New Jersey region during October, 1985, through March, 1986, confirms the existence of an annually occurring overwintering aggregation of shortnose sturgeon in the immediate vicinity of Duck Island Creek. An overwintering population of 2122 adults was calculated using the modified Schnable population estimator (Ricker, 1975).

In the fall, the bulk of the population migrates downstream and utilizes the lower estuary as an overwintering area (Hastings, 1983b). This group includes non-ripening adults, ripe but not running males, and older juveniles. The remaining portion of the population, including ripening adults, some non-ripening adults, and juveniles, overwinters in freshwater near the spawning grounds.

Freshwater overwintering areas in the Delaware River include the area between Roebling and Trenton, NJ. The largest winter aggregations of shortnose sturgeon have been located in the Duck Island range with 53, 26, and 50 individuals captured on single sampling days in November 1982, November 1983, and December 1984, respectively.

In the spring, when water temperatures reach 8 to 9° C, adults migrate from the lower estuary and freshwater overwintering sites, upstream to upper tidal and lower non-tidal spawning grounds (Dovel, 1978; Squires, 1982). In the Delaware River, recent studies indicate that the area below Scudder's Falls is commonly used by shortnose sturgeon to spawn (Brundage, 1984). After spawning, adults migrate downstream to summer foraging areas. Some remain in freshwater while others move to mid-estuary. Individuals have been captured throughout the Roebling to Trenton area during the summer, with Newbold Island and Duck Island sites being most productive.

Juveniles generally remain in freshwater year-round until they reach maturity. To date, extensive sampling has not identified the location of juvenile shortnose sturgeon in the upper tidal Delaware River. Sampling has included small and large mesh gill nets and otter trawls in 1981, bottom set plankton nets in 1982, seining in 3 Delaware River tributaries near Duck Island in 1983, small and large mesh gill nets in 1984, and examination of stomach contents of potential predators. Eleven possible juvenile shortnose sturgeon ranging in size from 387 to 499 mm fork length were captured at several locations

between Trenton and Newbold Island during all seasons of the year. Eggs, larvae, and smaller juveniles have not been located.

3.11.3 DISTRIBUTION IN PROJECT AREA

The Philadelphia District of the USACE funded an underwater video survey in the Marcus Hook region between March 4 and March 25, 2005 (Burton et al. 2005). A total of 43 hours of bottom video were collected on 14 separate survey days. Twelve days of survey work were conducted in the project area, specifically the Marcus Hook, Eddystone, Chester, and Tinicum navigational ranges, while two separate days of survey work were conducted up river near Trenton, New Jersey, at an area known to have an overwintering population of shortnose sturgeon. Three unidentified juvenile sturgeons were captured in the video images in the Marcus Hook area. Gill net collections conducted during the video work produced one juvenile Atlantic sturgeon.

The Marcus Hook blasting area is adjacent to a proposed site for an LNG terminal called Crown Landing located in Logan Township, New Jersey. Major dredging and in-water construction of offloading facilities prompted the developer, BP Petroleum, to fund studies of shortnose sturgeon occurrence and distribution in the region. These studies were conducted by Brundage and O'Herron who summarized their results in a series of reports (ERC 2004, 2005, 2006a, 2006b, 2007) and in a Biological Assessment submitted to NMFS through the Federal Energy Regulatory Commission (FERC). The research included gill net surveys and sonic tagging of shortnose and Atlantic sturgeon juveniles and adults. These studies indicated that shortnose sturgeon are present in the Marcus hook region of the Delaware River at least during the April – August time frame. The following is a summary of Brundage and O'Herron findings included in the NMFS Biological Opinion for the Crown Landing LNG project (NMFS Biological Opinion letter dated May 23, 2006)

"The objective of the survey is to obtain information on the occurrence and distribution of juvenile shortnose and Atlantic sturgeon. Sampling for juvenile sturgeon was performed using trammel nets and small mesh gill nets. The nets were set at three stations, one located adjacent to the project site, one at the upstream end of the Marcus Hook anchorage (approximately 2.7 miles upstream of the project site), and one near the upstream end of the Cherry Island Flats (approximately 3.8 miles downstream of the site). Nets were set within three depth ranges at each station: shallow (<10 feet at MLW), intermediate (10-20 feet at MLW) and deep (20-30+ feet at MLW). Each station/depth zone was sampled once per month. Nets were fished for at least 4 hours when water temperatures were less than 27°C and limited to 2 hours when water temperature was greater than 27°C. The sampling from April through August 2005 yielded 3,014 specimens of 22 species, including 3 juvenile shortnose sturgeon. Juvenile shortnose sturgeon were collected one each during the June, July and August sampling events. Two of the shortnose sturgeon were collected adjacent to the project site and one was taken at the

downstream sampling station. Total length ranged from 311-367mm. Preliminary results from the September - December sampling show that one juvenile shortnose sturgeon was caught in September (adjacent to the project site) and one in November (specific location unreported). One adult shortnose sturgeon was captured in October at the downstream site. All of the shortnose sturgeon were collected in deep water sets (greater than 20 feet). These depths are consistent with the preferred depths for foraging shortnose sturgeon juveniles reported in the literature (NMFS 1998). The capture of an adult in the Cherry Island Flats area (the downstream site) is consistent with the capture location of several adult sturgeon reported by Shirry et al. 1999.

Brundage compiled a report presenting an analysis of telemetry data from two receivers located upstream (Torresdale RKM 150 and Tinicum RKM 139) and two receivers located downstream of the Crown Landing site (Bellevue RKM 117 and New Castle RKM 93), during April through December 2003. The objective of the study was to provide information on the occurrence and movements of shortnose sturgeon in the general vicinity of the site. A total of 60 shortnose sturgeon had been tagged with ultrasonic transmitters: 30 in fall 2002, 13 in early summer 2003 and 13 in fall 2003. All fish tagged were adults tagged after collection in gill nets in the upper tidal Delaware River, between RKM 203-212. Of the 60 tagged sturgeon, 39 (65%) were recorded at Torresdale, 22 (36.7%) were recorded at Tinicum, 16 (26.7%) at Bellevue and 18 (30%) at New 50 Castle. The number of tagged sturgeon recorded at each location varied with date of tagging. Of the 30 sturgeon tagged in fall 2002, 26 were recorded at Torresdale, 17 at Tinicum, 11 at Bellevue and 13 at New Castle. Only two of the 13 tagged in fall 2003 were recorded, both at Torresdale only. Brundage concludes that seasonal movement patterns and time available for dispersion likely account for this variation, particularly for the fish tagged in fall 2003. Eleven of the 30 shortnose sturgeon tagged in fall 2002 and 5 of the 17 fish tagged in summer 2003 were recorded at all four locations. Some of the fish evidenced rapid movements from one location sequentially to the next in upstream and/or downstream direction. These periods of rapid sequential movement tended to occur in the spring and fall, and were probably associated with movement to summer foraging and overwintering grounds, respectively. As a group, the shortnose sturgeon tagged in summer 2003 occurred a high percentage of time within the range of the Torresdale receiver. The report concludes that the metrics indicate that the Torresdale Range of the Delaware River is utilized by adult shortnose sturgeon more frequently and for greater durations than the other three locations. Of the other locations, the New Castle Range appears to be the most utilized region. At all ranges, shortnose were detected throughout the study period, with most shortnose sturgeon detected in the project area between April and October. The report indicates that most adult shortnose sturgeon used the project area as a short-term migratory route rather than a long-term concentration or foraging area. Adult sturgeon in the project area are highly mobile, and as noted above, likely using the area as a migration route. Based on the best available

information, eggs, larvae and young of the year are not likely to occur at the project site. Information on the use of the river by juveniles is lacking and the information available is extremely limited (i.e., 5 captures). Juvenile shortnose sturgeon have been detected at the site from June - November, although only in deep water. Based on an analysis presented in the BA, the April – August time frame is when flows in the Delaware River are highest and the time when the project area is likely to experience the low salinity levels preferred by juveniles. Beginning in August, flows decrease and the salt wedge begins to move upstream, which may preclude juveniles from using the site. Based on this information, it is likely that juvenile shortnose sturgeon are present at the project site at least during the April – August time frame. The capture of juvenile shortnose sturgeon through November of 2005 suggests that if water conditions are appropriate, juveniles may also be present in the project area through the fall. While it is possible, based on habitat characteristics, that this area of the river is used as an overwintering site for juveniles, there is currently no evidence to support this presumption. The best available information suggests that adult shortnose sturgeon are using the project site as a migration corridor between downstream foraging sites (possibly located near Cherry Island flats) and the upstream spawning and overwintering areas. Adults are likely to transit the area between April and early December, with the majority of shortnose sturgeon adults moving to the overwintering area by mid-November when water temperatures drop to 10°C. This assumption is supported by water quality data from the USGS stream gauge in Philadelphia which indicates that water temperatures typically fall to 10°C (thought to be the trigger for movement to overwintering areas) in mid-late November and return to above 10°C in early April7."

3.11.4 FOOD

Shortnose sturgeon are suctorial feeders, with a protuberant mouth used to vacuum the bottom and plant surfaces. Feeding habitat is characterized as shallow weedy areas, with sandy-mud and mud bottoms. In freshwater, adults predominantly feed on available mollusks, however, Taubert and Dadswell (1980) and Curran and Ries (1937) observed shortnose sturgeon feeding on benthic crustaceans and insects. This may reflect prey availability, or be the result of non-selective suctorial feeding behavior. Marchette and Smiley (1982) observed a shift in food preference from mollusks in freshwater to polychaetes in saline areas. McCleave et al. (1977) observed adults in Montsweag Bay, Maine (salinity 18-24 ppt) feeding on *Mya*, *Crangon*, and *Pseudopleuronectes*. Juveniles feed on benthic insects and crustaceans including *Hexagenia*, *Chaoborus*, *Chironomus*, *Gammarus*, *Asellus*, and *Cyathura* (Pottle and Dadswell, 1979; Taubert, 1980). Their diet may vary, again dependent on availability of prey organisms.

In the Delaware River, the Asiatic river clam (*Corbicula manilensis*) is considered to be a primary food source for

shortnose sturgeon (Hastings, 1985). *Corbicula* is widely distributed at all depths in the upper tidal Delaware River, although it is considerably more numerous in shallows on both sides of the river than in the channel. Oligochaetes and Tendipedidae are also abundant in the vicinity of the sampling area. Additional taxa include Hirudinea, Odonata, *Anguilla rostrata*, Amphipoda, Polychaetes, Nematoda, and *Ferrissia*. Freshwater feeding activity appears to be confined to portions of the year when water temperature is greater than 10° C (Dadswell, 1979; Marchette and Smiley, 1982). Feeding that does occur during the colder months is at a depth of 15-25 m. Feeding activity in saline water occurs year-round, although an analysis of stomach contents suggests that feeding is less frequent during the winter (Dadswell, 1979; Marchette and Smiley, 1982).

Juveniles feed primarily in river channels 10-20 m deep over sandy-mud or gravel-mud bottoms (Pottle and Dadswell, 1979). To date, attempts to locate juvenile shortnose sturgeon in the upper tidal Delaware River have been unsuccessful. Thus, very little is known about their specific feeding habits.

4.0 LISTED SPECIES WITHIN THE PROJECT AREA

Listed species that may occur within the project area include right, humpback, and fin whales; loggerhead, leatherback, Kemp's ridley, hawksbill and green sea turtles; and shortnose sturgeon. All of these species are endangered, except for the loggerhead sea turtle, which is threatened. Due to the limited available data on sea turtles and whales within the Philadelphia District's jurisdiction, it was determined through coordination with the National Marine Fisheries Service that all hopper dredging activities conducted below the Delaware Memorial Bridge during June through mid-November would include whale monitoring and the presence of sea turtle observers on board the dredge during operations.

4.1 SEA TURTLES

All five species of sea turtles have been reported in the Delaware River Estuary and along the coast of New Jersey and Delaware. Loggerhead and Kemp's ridley sea turtles are distributed throughout the Bay. The leatherback, and green sea turtles occur primarily in coastal areas of New Jersey and Delaware and around the mouth of the Bay. The hawksbill is generally considered rare in these northern waters, but as with all these listed turtles could be in either the coastal waters or the Delaware Bay.

4.1.1 HISTORICAL ENDANGERED SPECIES MONITORING PROGRAM RESULTS

The Philadelphia District Endangered Species Monitoring Program began in August 1992. Four hopper dredging projects were conducted within the Philadelphia District between August 1992

and August 1994. Those projects were as follows:

Beach nourishment - Bethany Bay, Delaware - 8/25 to 10/13/92
Beach nourishment - Cape May, New Jersey - 10/24 to 11/14/92
Channel maintenance - Delaware River & Bay - 6/23 to 8/19/93
Channel maintenance - Delaware River & Bay - 6/13 to 8/10/94

While on board the dredges, NMFS approved observers worked closely with the dredge crew to identify and record dredging incidents with sea turtles and other endangered species. Sampling for turtles and turtle parts was accomplished through observation and inspection of the hopper along with screening of the intake structure or hopper overflow. The observers stayed on board the hopper dredges and conducted monitoring of the baskets and screening of the inflow or overflow for sea turtles.

The observers provided educational materials to dredge personnel on sea turtles, whales, and instructed the dredge operator in the proper procedures used for documenting any whale sightings (the dredge operator was responsible for recording the presence of any whales within or around the project site). The observer also advised dredge personnel that there are civil and criminal penalties for harming, harassing, or killing sea turtles and whales that are protected under the Endangered Species Act and the Marine Mammal Protection Act.

The sea turtle observer was on board the dredge during the first week of each dredging operation. Following the first week, the observer was on board the dredge on a biweekly basis or as appropriate so that the total aggregate time on board the dredge equaled 50 percent of the total time of the dredging operation. While on board the dredge the observer provided the required inspection coverage on a rotating, six (6) hours on and six (6) hours off, basis. In addition, these rotating six (6) hour periods varied from week to week. The data collected during these projects was used, along with additional data to prepare this biological assessment.

During the beach nourishment projects at Bethany Bay, Delaware (8/25 to 10/13/92) and the Cape May, New Jersey (10/24 to 11/14/92) there were no sea turtles spotted from the dredge in work areas. In addition, no incidents of injury or mortality concerning target species were detected during monitoring periods.

The dredge MCFARLAND worked in the Delaware River entrance from 06\23\93 to 07\23\93 and at Cape May, New Jersey bay side from 07\24\93 to 08\02\93 and 08\10\93 to 08\19\93. There were two documented incidents involving protected species during this project. Both were taken at Cape May within three days of each other, and involved loggerhead sea turtle tissue which was found in the inflow screening. In addition, documented sightings from the bridge watch included 2 loggerhead sea turtles and one unidentified sea turtle in Cape May, New Jersey.

The MCFARLAND did more work in the Delaware entrance channel between 06/13/94 to 08/10/94. During this dredging cycle a "Protective Relocation and Assessment of Sea Turtle Abundance Program" was conducted, along with the standard monitoring on the dredge. Despite the relocation efforts, there was one documented incident involving protected species. This occurred on June 22, 1994 when a loggerhead turtle was taken by the dredge. Subsequently, for the remainder of the dredging cycle, monitoring coverage was increased to 100 percent and deflectors were installed on both dragarms.

During the course of the relocation program a total of 8 loggerhead sea turtles were captured and relocated. Most of the turtles were captured at inshore stations when water temperatures were $\geq$ 27°C.

4.1.2 RECENT ENDANGERED SPECIES MONITORING PROGRAM RESULTS (AFTER 1994)

Sea turtle monitoring activities within the District have continued as described above since 1994. One change that has been implemented is that observers are now on the dredge for 100% of the time, monitoring on 6 or 8 hour shifts. This was done for logistical contracting reasons but had the added benefit of increasing the total monitoring time to 50% of dredging activities.

On November 3, 1995 one loggerhead turtle was taken by a hopper dredge during work being conducted in Delaware River Entrance Channel.

In 1999, the USACE endangered species observer noted three dead loggerheads floating in the Delaware River during the dredging event. The deaths were not due to interaction with the Corps' dredge. Turtles were observed in the vicinities of Brandywine Shoal and Reedy Island.

On July 27, 2005 parts of a loggerhead turtle were found in the hopper basket by the onboard observer. It probably represented one turtle but the turtle parts were found in two different hoper loads. Dredging was being conducted in the Miah Maul Range of Delaware Bay.

All of these takes were fully coordinated with the NMFS.

4.1.3 TURTLE STRANDINGS IN THE REGION

The standings information summarized in Tables 3 and 4 were obtained from the Sea Turtle Stranding and Salvage Network (STSSN) for the 1998 to 2004 time frame.

Loggerheads were the most common sea turtle species observed in the stranding data. In Coastal Delaware and Delaware Bay 196 leatherback strandings were reported between 1988 and 2004 (Table

3) while in coastal New Jersey and the New Jersey side of Delaware Bay 204 leatherbacks were reported (Table 4). Most of the leatherback strandings were reported in Sussex County, Delaware and Atlantic County, New Jersey on Atlantic Ocean beaches.

Kemp's ridleys were not as common as loggerheads but 17 turtles were reported in the State of Delaware (coastal and Delaware Bay beaches) while 15 were reported in New Jersey coastal and Delaware Bay beaches. Leatherback strandings in New Jersey (90) outnumbered Delaware strandings (20). Only five total strandings of Green turtles were reported between Delaware and New Jersey coastal and bay beaches between 1998 and 2004.

Monthly strandings from the time series indicated that most Loggerhead strandings occurs during the months June through October and peaking in September in New Jersey beaches. Although lesser strandings were reported for Kemp’s ridley and leatherback turtles, they had a similar summer to fall distribution of strandings.

4.2 WHALES

Records indicate that the endangered humpback whale, fin whale and right whale have occasionally been sighted in the Delaware Estuary. However, since the introduction of the Endangered Species Act in 1973, whales have been sighted with increasing frequency along the New Jersey and Delaware Coast, and have become the subject of a growing whale watch industry in the mid-Atlantic.

During the Philadelphia District's Endangered Species monitoring program in September 1992, humpback whales were sighted near the project area at Fenwick Island and Bethany Beach. During the channel maintenance project in Delaware Bay (summer of "93") 47 bottlenose dolphins were sighted off of Cape May. There were no whale sighting during the Cape May beach nourishment project (8/25/92 to 10/13/92). Two to six northern right whales have been sighted each winter off of Long Island and off of New Jersey Beaches. Historical observations also indicate that humpback and fin whales are present offshore near the mouth of the Chesapeake Bay. While population numbers are not available, presence of these whales is reported in the months of January, February, and March.

Table 5 summarized the stranding data from 1988 to 2008 for fin, humpback, and right whales. This information was provided by NOAA’s Marine Mammal stranding database.

Table 3 Sea Turtle Strandings in Coastal Delaware and Delaware Bay

Annual Distribution

YEAR	Loggerhead			Kemp's ridley			Leatherback		
	Sussex (Ocean)	Kent / New Castle (Bay)	All Counties	Sussex (Ocean)	Kent / New Castle (Bay)	All Counties	Sussex (Ocean)	Kent / New Castle (Bay)	All Counties
1998	19	4	23	2	0	2	0	0	0
1999	31	5	36	2	2	4	2	0	2
2000	23	2	25	3	0	3	1	0	1
2001	10	4	14	2	0	2	3	0	3
2002	34	6	40	3	0	3	2	0	2
2003	28	8	36	0	0	0	0	0	0
2004	20	2	22	3	0	3	12	0	12
Total	**165**	**31**	**196**	**15**	**2**	**17**	**20**	**0**	**20**

YEAR	Green			Unknown					
	Sussex (Ocean)	Kent / New Castle (Bay)	All Counties	Sussex (Ocean)	Kent / New Castle (Bay)	All Counties			
1998	0	0	0	0	0	0			
1999	0	0	0	4	1	5			
2000	0	0	0	1	0	1			
2001	0	0	0	0	2	2			
2002	1	0	1	1	1	2			
2003	0	0	0	2	2	4			
2004	1	0	1	6	1	7			
Total	**2**	**0**	**2**	**14**	**7**	**21**			

Table 3 Continued

Monthly Distribution

NOTE: Monthly summaries include data from 1998-2004

Month	Loggerhead	Kemp's ridley	Leatherback	Green	Unknown				
Jan	1	0	0	0	0				
Feb	0	0	0	0	0				
March	0	0	0	0	0				
April	1	0	0	0	1				
May	1	0	0	0	0				
June	47	0	2	0	5				
July	26	2	2	0	2				
Aug	30	1	1	1	3				
Sept	49	2	13	1	5				
Oct	34	6	1	0	4				
Nov	6	5	1	0	1				
Dec	1	1		0	0				
Total	**196**	**17**	**20**	**2**	**21**	**256**			

NOTE: Data was queried by county. Kent and New Castle counties were considered "Delaware Bay" strandings. Sussex county was considered Delaware "Atlantic Ocean" strandings.

Table 4 Sea Turtle Strandings in Coastal New Jersey and Delaware Bay

Annual Distribution

Year	Loggerhead				Kemp's ridley				Leatherback			
	Cumberland/ Salem (Bay)	Cape May (Mouth of Bay)	Atlantic County & North (Ocean)	All Counties	Cumberland / Salem (Bay)	Cape May (Mouth of Bay)	Atlantic County & North (Ocean)	All Counties	Cumberland/ Salem (Bay)	Cape May (Mouth of Bay)	Atlantic County & North (Ocean)	All Counties
1998	1	19	22	42	0	1	0	1	0	3	1	4
1999	3	25	49	77	0	0	2	2	1	0	8	9
2000	1	8	26	35	0	0	2	2	0	1	7	8
2001	1	13	21	35	0	0	2	2	0	1	8	9
2002	0	12	31	43	0	0	4	4	0	6	13	19
2003	0	11	26	37	0	1	0	1	0	6	11	17
2004	0	17	29	46	0	0	3	3	0	3	21	24
Total	**6**	**105**	**204**	**315**	**0**	**2**	**13**	**15**	**1**	**20**	**69**	**90**
Year	Green				Unknown							
	Cumberland/ Salem (Bay)	Cape May (Mouth of Bay)	Atlantic County & North (Ocean)	All Counties	Cumberland / Salem (Bay)	Cape May (Mouth of Bay)	Atlantic County & North (Ocean)	All Counties				
1998	0	0	0	0	1	2	3	6				
1999	0	0	0	0	1	1	1	3				
2000	0	0	2	2	0	3	2	5				
2001	0	0	0	0	0	2	1	3				
2002	0	0	0	0	0	3	3	6				
2003	0	0	0	0	0	0	2	2				
2004	0	1	0	1	0	2	4	6				
Total	**0**	**1**	**2**	**3**	**2**	**13**	**16**	**31**				

Table 4 Continued

Monthly Distribution

NOTE: Monthly summaries include data from 1998-2004

Month	Loggerhead	Ridley	Leatherback	Green	Unknown							
Jan	1	0	2	0	0							
Feb	0	0	0	0	0							
March	0	0	0	0	1							
April	0	0	2	0	0							
May	2	0	1	0	0							
June	42	0	1	0	1							
July	59	4	15	0	9							
Aug	69	5	16	0	4							
Sept	106	4	39	3	9							
Oct	33	2	10	0	5							
Nov	3	0	3	0	2							
Dec	0	0	1	0	0							
Total	**315**	**15**	**90**	**3**	**31**	**454**						

NOTE: Data was queried by county. Cumberland and Salem counties were considered New Jersey "Delaware Bay" strandings. Cape May county is considered New Jersey "Mouth of Delaware Bay" strandings, and Atlantic County and all other counties north were considered New Jersey "Atlantic Ocean" strandings.

Table 5 Summary of fin, humpback, and right whale strandings in the states of Delaware and New Jersey reported from 1988 to 2008			
Common Name	Observation Year	Stranding State	Locality Detail
FIN WHALE	1988	NJ	Deal casino beach front; Originally found floating off Barnegat Light
HUMPBACK WHALE	1989	NJ	200 yards E of Shrewbury Rocks
HUMPBACK WHALE	1991	NJ	A-14 and beach
FIN WHALE	1992	NJ	38th St. and beach
FIN WHALE	1992	NJ	72nd St. and beach
FIN WHALE	1992	NJ	
HUMPBACK WHALE	1992	DE	Fowlers Beach, 1/2 mile south of Rt. 199. Part of Primehook Wildlife Refuge.
HUMPBACK WHALE	1993	DE	Cape Henlopen State Park
HUMPBACK WHALE	1993	NJ	Seven Presidents Park, south end of park, on the beach
HUMPBACK WHALE	1993	NJ	E. Mercer Rd. And beach
HUMPBACK WHALE	1995	NJ	About 100 miles east of NJ
FIN WHALE	1996	NJ	Floating in Elizabeth channel, adjacent to Maersk shipping lines
FIN WHALE	1996	NJ	Delaware Ave. In the Delaware River
HUMPBACK WHALE	1996	DE	Cape Henlopen State Park
HUMPBACK WHALE	1996	NJ	About 20 miles southeast of Cape May NJ
FIN WHALE	1996	NJ	About 50 miles east of NJ
FIN WHALE	1996	NJ	About 60 miles east of NJ
FIN WHALE	1996	NJ	About 80 miles east of NJ

Table 5 Continued			
Common Name	Observation Year	Stranding State	Locality Detail
FIN WHALE	1998	DE	Approx 5.5 mi. Southeast of Rehoboth beach when first sighted
FIN WHALE	1998	NJ	Approx. 52 miles east of Atlantic city
FIN WHALE	1998	NJ	Floating in port Elizabeth channel
FIN WHALE	1999	NJ	Elizabeth Seaport berth 61
NORTHERN RIGHT WHALE	1999	NJ	5 miles off of Stone Harbor.
FIN WHALE	2001	NJ	Found floating in New York harbor by Bayonne military ocean terminal
HUMPBACK WHALE	2001	NJ	Floating 5-6 miles east of seaside heights, New Jersey
FIN WHALE	2001	NJ	Newark bay, New Jersey
HUMPBACK WHALE	2001	NJ	Floating 3 miles offshore, washed ashore on 9/9/01 at 11th Ave in Belmar New Jersey
HUMPBACK WHALE	2001	NJ	Young's Ave and the beach
HUMPBACK WHALE	2001	NJ	4th Ave and the beach
HUMPBACK WHALE	2003	NJ	28th Street and the beach
FIN WHALE	2003	NJ	Fish and wildlife property - refuge
HUMPBACK WHALE	2004	DE	Sea colony
FIN WHALE	2004		150 miles east of Sandy Hook, NJ
FIN WHALE	2004	NJ	Army Corps of Engineers Pier
FIN WHALE	2004	NJ	North Gunnison beach, Sandy Hook Gateway National Park
FIN WHALE	2005	NJ	Port elizabeth,1020 North Fleet St., berth 80. Newark Bay

Table 5 Continued			
Common Name	Observation Year	Stranding State	Locality Detail
FIN WHALE	2006	DE	Middlesex Beach, between Bethany and South Bethany
HUMPBACK WHALE	2006	DE	North of navy crossing at Cape Henlopen State Park
HUMPBACK WHALE	2006	NJ	Wisteria Rd. and the beach
FIN WHALE	2007	NJ	Floating near buoy #14 in Newark Bay; approx. 0.5 miles from the end of 24th Street in Bayonne
FIN WHALE	2008	NJ	Seven Presidents Park
FIN WHALE	2008	NJ	Island beach State Park

4.3 SHORTNOSE STURGEON

Biological information from the 1986 Connecticut River sturgeon research, and studies conducted in 1986-1987 by Rutgers University on shortnose sturgeon were incorporated into this biological assessment. In addition recent studies conducted by O'Herron, Able, and Hastings (June 1993), Versar (2005), and Environmental Research and Consulting between 2002 and 2007 near the proposed Crown Landing LNG terminal in Logan Township New Jersey have also been incorporated into this assessment.

The seasonal distribution of shortnose sturgeon in the Delaware River in some ways corresponds to the generalized pattern of shortnose sturgeon in the Saint John, Hudson and Kennebec Rivers. Seasonal distribution appears to be dependent upon life stage, reproductive state, and latitude. During the fall, in the Saint John, Hudson, and Kennebec Rivers, the bulk of the population migrates downstream and utilizes the lower estuary as an overwintering area (Hastings, 1983b). This group includes non-ripening adults, ripe but not running males, and older juveniles. The remaining portion of the population, including ripening adults, some non-ripening adults, and juveniles, overwinters in freshwater near the spawning grounds. Juveniles generally remain in freshwater year-round until they reach maturity. However, in the Delaware River, after spawning the fish move rapidly downstream into or near the limits of salt water intrusion (Dadswell et al. 1984; Hall et al. 1991).

The movement patterns appear to be relatively simple, but Buckley and Hynard (1985), using telemetry to track the shortnose sturgeon in the lower Connecticut River, have found underlying complex patterns that they could relate to sex and reproductive conditions. During the fall the Connecticut River pre-spawning adult sturgeon migrate upstream for the first occasion to move to the spawning grounds at Holyoke. In the winter, shortnose sturgeon that have not yet moved to Holyoke either remain at Agawam and Hartford, or move downstream to the lower estuary concentration sites.

As temperatures rise in the spring, a second migration of pre-spawning adults to Holyoke Dam occurs from Agawam and Hartford. After spawning in May, adults and juveniles migrate downstream to feed at Agawam, Hartford and the lower estuary. By August most fish begin to move back upstream to Agawam, Hartford or the spawning grounds.

Delaware River shortnose sturgeon overwinter in dense, sedentary aggregations between river km 190 and river km 210, especially in the vicinity of Duck Island. In late March through April, spawning aggregations are found primarily between Scudders Falls and the Trenton Rapids. Males appear to remain in the spawning area for longer periods, while females are present for a relatively short duration. Postspawning males and females move rapidly downstream into the Philadelphia area during April-May.

Many of these return upriver to between river km 205 and river km 215 within a few weeks, while the others gradually move to the same area over the course of the summer. By November a substantial overwintering aggregation has formed once again in the vicinity of Duck Island. These patterns are generally supported by the movement of ratio-tracked shortnose sturgeon in the region between river km 201 and river km 238 as presented by Brundage (1986). During studies conducted by O'Herron, Able, and Hastings (June 1993), recapture and tracking data demonstrate residency within and consistent returns to the uppermost tidal portion of the Delaware River regardless of sex and reproductive condition.

Research conducted in the 1970's suggested that the Delaware River population apparently overwinters in one relatively distinct area in fresh water, whereas other populations (St John, Hudson, and Kennebec Rivers) may overwinter in the broader portion of the estuary (Dadswell et al. 1984). There is no evidence that this population moves into the region of the fresh-water-saltwater interface during the summer, and little evidence that they use the higher salinity portions of the Delaware River estuary or Delaware Bay as do populations in other systems (McCleave et al. 1977; Dadswell 1979). At the time less than 20 have ever been collected south of the Philadelphia area (Brundage and Meadows 1982a; Dadswell et al. 1984).

The Marcus Hook blasting area is adjacent to a proposed site for an LNG terminal called Crown Landing located in Logan Township New Jersey. Major dredging and in water construction of offloading facilities prompted the developer, BP Petroleum, to fund studies of shortnose sturgeon occurrence and distribution in the region. These studies were conducted by Brundage and O'Herron who summarized their results in a series of reports (ERC 2004, 2005, 206a, 2006b, 2007) and in a Biological Assessment submitted to NMFS through the Federal Energy Regulatory Commission (FERC). The research included gill net surveys and sonic tagging of shortnose and Atlantic sturgeon juveniles and adults. These studies indicated that shortnose sturgeon are present in the Marcus hook region of the Delaware River at least during the April - August time frame.

5.0 IMPACTS OF DELWARE RIVER DEEPENING PROJECT

5.1 SEA TURTLE IMPACTS

In a Biological Opinion for the September 1995 Biological Assessment the Philadelphia District of the USACE submitted regarding all dredging activities (including the Delaware River deepening) NMFS determined that pipeline dredges are unlikely to adversely affect sea turtles. Pipeline dredges are relatively stationary and only influence small areas at any given time. For a turtle to be taken with a pipeline dredge, it would have to approach the cutterhead and be caught in the suction. This type of behavior would appear unlikely, but may be possible. This

position, of course, could change if new information suggests that sea turtle/pipeline dredge interactions occur.

Clamshell dredges are least likely to adversely affect sea turtles because they are stationary and impact very small areas at a given time. Any sea turtle injured or killed by a clamshell dredge would have to be directly beneath the bucket. The chances of this are extremely low, although a take of a live turtle by a clamshell was documented at Canaveral.

Only the hopper dredge has been implicated in the mortality of endangered and threatened sea turtles. Thus, this biological assessment concentrates on adverse impacts of hopper dredges that will be used for the main channel deepening project.

Among the several possible causes of death to sea turtles is the potential entrainment of individuals in hopper dredging apparatus. Incidental mortality of sea turtles due to channel dredging with hopper dredges became evident as a result of dredging in the Port Canaveral Channel, Florida in 1980 (Dickerson et al. 1991). This sheltered, low energy area is prone to shoaling and requires regular dredging to maintain the channel depth (Studt 1987). Initial investigations revealed an unusually high concentration of loggerhead turtles in the channel, possibly due to the physical characteristics of the channel (soft bottom, low energy, deeper water). These factors may make the ship channel an ideal resting area for adult and sub-adult turtles, and as a refuge from predators and an overwintering site for smaller turtles (Byles and Dodd 1989, Meylan et al. 1983, Carr et al. 1980). At the same time, however, the characteristics that make the Canaveral area favorable to sea turtles also make it a high maintenance area in terms of dredging. Thus, the potential for turtle/dredge interactions is high.

Impacts from dredging in the Delaware Estuary to listed species of sea turtles are dependent on the timing of the operations and the type of equipment employed. No impacts to any listed species of sea turtle would be expected if dredging were to be completed between December and May, or if equipment other than hopper dredges were employed to complete the work. However, there are potential impacts associated with hopper dredging conducted between June and November, when sea turtles may be present in the Delaware Estuary. Any of the five species of sea turtles could transit the channels during the warmer months, but only loggerhead and Kemp's ridley turtles are likely to be foraging in the channels, near the channel bottoms. The leatherback turtle is a pelagic feeder, with minimal bottom exposure. The number of loggerheads and Kemp's ridleys foraging in the Delaware Estuary is unknown, and it is not understood what percentage of the population within this area will avoid entrainment.

In the Delaware Estuary, dredging the channel will take crabs and other benthic organisms from the area. Hence, the food

resource values of these areas might be temporarily reduced for sea turtles. Because of the mobility of crabs and rapid recolonization of disturbed benthic communities in estuarine environments, resource values will begin to recover immediately.

Other threats to sea turtles in the Delaware Estuary and nearshore areas include drowning in trawl nets, entanglement and drowning in crab pot lines and pound net leader hedging, wounding from boat propellers, incidental capture at the Salem Generating Station, and entanglement, ingestion, and other complications from contact with marine debris, including petroleum products.

The destruction and/or modification of habitat from coastal development, and losses due to incidental capture during commercial fishing are likely the two major factors impacting sea turtle populations along the Atlantic Coast of the United States.

Incidental capture (take) is defined as the capture of species other than those towards which a particular fishery is directed. As implied by this definition, the commercial fishing industry has been implicated in many of the carcass strandings on southeast U.S. beaches. The annual catch of endangered Leatherback, Loggerhead Kemp’s ridley, and Green sea turtles by shrimp trawlers in the Gulf of Mexico and the southeast has been estimated at 962,000 turtles, primarily Kemp’s ridley. The average mortality rate was estimated to be about 86,000 turtle deaths per year (Epperly et al. 2002).

However, not all beach carcasses are the result of drowning in fish nets. Other human-related causes of mortality include damage from boating, plastic ingestion, etc. More research needs to be conducted to determine the precise cause of death of these animals. The unintentional capture of species during non-fishery related processes may also be considered as incidental capture. In New Jersey and New York, boat damage is a commonly observed injury in stranded turtles.

The loggerhead is the most numerous turtle in U.S. coastal waters, and therefore would be encountered most frequently by fishermen and recreational boaters.

East coast stranding data for 1987 reported approximately 2,500 animals for the Atlantic east coast (PSEG 1989). The greatest number of these strandings were observed along the southeastern Atlantic coast (i.e. Florida). Even though any loss of an endangered or threatened species is important, the magnitude of the losses of loggerhead and Kemp's ridley sea turtles from hopper dredging for the Delaware River deepening would not be expected to significantly impact the U.S. Atlantic coast populations of these sea turtle species.

5.2 IMPACTS TO WHALES

Impacts to listed species of whales are unlikely with any type of dredging equipment. During operation, a dredge moves very slowly. Only during dredge transit to and from a work area or disposal site does the speed increase. The only means of potential impact is thought to be by collisions between vessels and whales during transit. Based on existing vessel traffic, this potential is considered insignificant. The Delaware River deepening is not anticipated to increase the vessel traffic to Delaware and Philadelphia ports. The primary purpose of the deepening project is to increase the efficiency of the vessels currently using the river. The increase in channel depth will reduce the need to lighter oil tankers in Delaware Bay before traversing up the Delaware River and allow more dry cargo to be carried by other vessels. This has the potential to decrease shipping traffic by reducing barge traffic and allowing goods to reach the ports with fewer vessel trips.

5.3 IMPACTS TO SHORTNOSE STURGEON

Construction of the main channel deepening project is of concern with respect to impacts to shortnose sturgeon. Recent research in the Marcus Hook area has confirmed that juvenile shortnose sturgeon inhabit the Chester-Philadelphia area. Habitat destruction would be minimal in this area because a large percentage of the new construction and all of the maintenance dredging would occur in existing channels, which comprise a small portion of the river. It is expected that most adult sturgeon would actively avoid a working dredge. However, some takes have occurred including:

- On March 18, 1996; Two sturgeon carcasses were found in the Money Island Disposal Area. The sturgeon take probably occurred two weeks prior to the discovery in the disposal area when the Newbold Navigational range was being dredged.

- In January 1998; Three sturgeon carcasses were discovered in the Money Island Disposal Area. The sturgeon were found on three separate dates 1/6, 1/12, and 1/13. Dredging was being conducted in the Kinkora and Florence ranges when takes occurred.

Based on the studies conducted between Philadelphia and Trenton by Rutgers University for the Philadelphia District of the U.S. Army Corps of Engineers, the 1986 Connecticut River sturgeon research, and studies conducted by O'Herron, Able, and Hastings (June 1993), it has been concluded that major shortnose sturgeon aggregation sites are located within the Trenton to Newbold Island portion of the Delaware River Federal Navigation Project (U.S. Army Corps of Engineers Delaware River stationing 160 + 352.48 to 112.439.16). This part of the river is above the Delaware River Deepening project area.

As part of the Delaware River deepening project

approximately 77,000 cubic yards of bedrock, covering 18 acres near Marcus Hook, Pennsylvania (River Mile 76.4 to River Mile 84.6) would be removed to deepen the navigation channel to a depth of 47-ft mean low water. Blasting operations would occur up to five days a week between 1 December and 15 March, but the actual blasting would only occur for a brief period each day (Philadelphia District, 1997). Blasting could impact the shortnose sturgeon in two ways: physical injury or mortality to individual fish, and damage to habitat.

5.3.1 PHYSICAL INJURY

Several studies have demonstrated that underwater blasting can cause fish mortality (Teleki and Chamberlain 1978, Wiley et al. 1981, and Burton 1994). These studies have shown that size of charge and distance from detonation are the two most important factors in determining fish mortality from blasting. Depth of water, type of substrate, and the size and species of fish present also affect the number of fish killed by underwater explosions.

Teleki and Chamberlain (1978) conducted blasting mortality experiments in Long Point Bay, Lake Erie, at depths of 4 to 8 m. Fish were killed in radii ranging from 20 to 50 m for 22.7-kg charges and from 45 to 110 m for 272-kg charges during 28 monitored blasts. Explosives were packed into holes bored into the lake bottom. The kind of substrate determined the decay rate of the pressure wave, and mortality differed by species at identical pressure. Teleki and Chamberlain (1978) presented their results for several species in terms of 10% and 95% mortality radii (i.e., radii at which 10% and 95% of the caged fish were killed).

Wiley et al. (1981) measured the movement of fish swim bladders to estimate blast mortality for fish held in cages at varying depths during midwater detonations of 32-kg explosives in the Chesapeake Bay. Pressure gages were placed in cages that contained spot (*Leiostomus xanthurus*) and white perch (*Morone americana*). The study was conducted at the mouth of the Patuxent River in depths of about 46 m. Using data collected during 16 blasts, Wiley and colleagues predicted the distances at which 10%, 50%, and 90% mortality of white perch occurred. For 32-kg charges, the pressure wave was propagated horizontally most strongly at the depth at which the explosion occurred.

Burton (1994) conducted experiments on the Delaware River to estimate the effects of blasting to remove approximately 1,600 cubic yards of bedrock during construction of a gas pipeline. Charges of 112 and 957 kg of explosives were detonated in the river bed near Easton, Pennsylvania, during July 1993 in depths ranging between 0.5 and 2.0 m. American shad juveniles (*Alosa sapidissim*) were caged at a range of distances from the blasts. In the larger of the two blasts all fish in cages positioned farther than 24 meters (78 feet) from the blast survived.

In Wilmington Harbor, Wilmington, North Carolina, studies were done to determine the impacts of blasting on shortnose sturgeon (Wilmington District, 2000). To determine the impacts of blasting on shortnose sturgeon and size of the LD1 area (the lethal distance from the blast where 1% of the fish died), test blasting was performed in Wilmington Harbor in the fall/winter of 1998/99. During test blasting, 50 hatchery reared shortnose sturgeon were placed in cages (2 feet diameter by 3 feet long plastic cylinders) 3 feet from the bottom (worst case survival scenario for blast pressure as confirmed by test blast pressure results) at 35, 70, 140, 280 and 560 feet up and downstream of the blast. Also, 200 caged sturgeon were held at a control location about ½ mile from the blast location. The caged fish had a mean weight of 55 grams and were young of the year fish. Sturgeon cages were enclosed in a 0.6 inch nylon mesh sock to prevent any sturgeon from escaping if the cage was damaged. This was necessary for preservation of the genetic integrity of the resident fish population since the hatchery reared shortnose sturgeon were not the same subspecies as the shortnose sturgeon in the Cape Fear River. Stemming and an approximate 25 millisecond delay between holes were used with 52-62 pounds of explosives per hole. Stemming is the use of a selected material, usually angular gravel or crushed stone, to fill a drill hole above the explosive. Stemming is commonly used to contain the explosive force and increase the amount of work done on the surrounding strata. Large explosive charges can be broken into a series of smaller charges by use of timing delays (Keevin and Hempen, 1997).

There were 3 test blasts with an air curtain in operation and 4 without an air curtain in operation. An air curtain is a stream of air bubbles created by a manifold system on the river bottom surrounding the blast. In theory, when the blast occurs the air bubbles are compressed, and the blast pressure is reduced outside the air curtain. The air curtain when tested, was 50 feet from the blast.

The caged fish were visually inspected for survival just after the blast and after a 24 hour holding period. The survival pattern just after the blast and after the 24 hour holding period were similar. Survival at the monitoring locations 140 feet and beyond just after the blast (with or without air curtain) was not significantly different. This 140 foot distance equals 2.1 acres and would be the edge of the LD1. Necropsies performed on the sturgeon also indicate that the impact area would not exceed 2.1 acres (Moser, 1999). A blast in the rock was calculated to be 0.014 of a blast in open water. In other words a 52 to 62 pound blast in rock is equivalent to a 0.73 to 0.87 pound blast in open water (Wilmington District, 2000).

5.3.2 HABITAT

Tagging studies done by O'Herron et al. (1993) show that the most heavily used portion of the river appears to be between river mile 118 below Burlington Island and the Trenton Rapids at

river mile 137, which is about 33 river miles above the blasting project which is located below river mile 84.6. Spawning habitat has been located above Trenton, New Jersey (O'Herron and Hastings, 1985), at about river mile 131. This is over 46 river miles above the blasting and should not be impacted. Overwintering concentrations of adult shortnose sturgeon have been found between river mile 118 and 131 which is also over 33 river miles from the blasting site which is located below river mile 84.6.

Shortnose sturgeon generally feed when the water temperature is greater than 10^{0}C (Dadswell, 1979 and Marchette and Smiley, 1982) and in general, feeding is heavy immediately after spawning in the spring and during the summer and fall, and lighter in the winter. Since this blasting in the Marcus Hook navigational range is planned for the winter months, there should be no impact on sturgeon foraging. The Asiatic river clam (*Corbicula manilensis*, or *Corbicula fluminea*) is considered to be the primary food source for the shortnose sturgeon (O'Herron and Hastings, 1985). Fine clean sand, clay, and coarse sand are preferred substrates for this clam, although this species may be found in lower numbers on most any substrate (Gottfried, and Osborne, 1982; Belanger et al., 1985; Blalock and Herod, 1999). Gottfried and Osborne (1982) reported density as lowest on bottoms composed of silty organic sediments. Since the substrate is primarily rock, it is not considered prime habitat for the Asiatic clam; however, Scott (1992) found high numbers (2596.14 per square meter) of *Corbicula* below Conowingo Dam on gravel and bedrock substrates in the Susquehanna River. The high densities may be the result of the high oxygen concentrations immediately below the dam. Much lower concentration (512 clams per square meter) were found in Florida in its preferred sand habitat (Blalock, H.N., and J.J. Herod. 1999).

Any benthic organisms that occur on the rock that is removed by blasting would be destroyed. The impact should not extend beyond the area of immediate impact since previous studies indicate that invertebrates are insensitive to pressure related damage from underwater explosions, which may be due to the fact that all the invertebrate species tested lack gas-containing organs which have been implicated in internal damage and mortality in vertebrates (Keevin and Hempen, 1997). Although there is no known information about invertebrate recovery time after blasting, data from other disturbances indicates that the benthic communities should become reestablished on the underlying rock within 2 years or less (New York District, 1999). It is unlikely that the blasting of rock to deepen the navigation channel will have a significant impact on the food source of shortnose sturgeons since the fish do light foraging during the time period when blasting would occur (winter) and since *Corbicula*, their favorite food source, is wide spread in the fresh water portion of the Delaware Estuary in more preferred habitats.

5.4 REASONABLE AND PRUDENT MEASURES TO MINIMIZE IMPACTS

5.4.1 SEA TURTLES

The Philadelphia District is concerned with the possible negative impacts that dredging may exert on threatened and endangered populations of sea turtles in the Delaware Estuary. They also recognize the need to monitor activities which may present a genuine threat to species of concern. It is the intention of the Philadelphia District to continue monitoring for sea turtles during dredging projects, when warranted. Sea turtle observer(s) shall be on board any hopper dredge working in areas of concern (below the Delaware Memorial Bridge) during June through November. The observer shall be on board the dredge continually during this window. While on board the dredge the observer shall provide the required inspection coverage on a rotating, six/eight hours on and six/eight hours off, basis. In addition, these rotating six/eight hour periods should vary from week to week. All such dredging and monitoring will be conducted in a manner consistent with the Incidental Take Statement issued by NMFS for this project. The District will continue to coordinate monitoring results with NMFS, and work to develop appropriate measures to minimize impacts.

5.4.2 WHALES

Due to the slow nature of whales it is the District's intention to slow down to 3 - 5 mph operating speed after sun set or when visibility is low when a whale is known to be in the project area. Contract plans and specifications will require the hopper dredge operator to monitor and record the presence of any whale within the project vicinity.

5.4.3 SHORTNOSE STURGEON

There may be a potential impact to overwintering juvenile shortnose sturgeon because rock blasting will be required to remove bedrock in the Marcus Hook range performed between 1 December and 15 March. The measures listed below focus on preventing physical injury to juveniles that may be near the blasting area, but would likely protect the larger adult fish if any were present since there is evidence that smaller fish are more vulnerable to injury than larger fish (Philadelphia District, 1997). Studies have shown that the size of charge and distance from detonation are the two most important factors in determining fish mortality from blasting (Teleki and Chamberlain 1978, Wiley et al. 1981, and Burton 1994). In addition, the measures listed below were used in North Carolina to successfully minimize impacts to shortnose sturgeon and have been coordinated with the NMFS for use with this project:

- Before each blast, four (4) sinking gillnets (5.5 inch mesh, 100 meters long) will be set to surround the blast area as near as feasible. These nets will be in place for at least 3

hours and none of the nets will be removed any sooner than 1 hour before the blast. This may require overnight sets. Any sturgeon removed (shortnose or Atlantic) will be released at a location approved by the National Marine Fisheries Service.

- Channel otter trawl nets will be set downcurrent of the blast area within 10 minutes of blast discharge in order to capture and document dead or injured fish.

- Scare charges will be used for each blast. A scare charge is a small charge of explosives detonated immediately prior to a blast for the purpose of scaring aquatic organisms away from the location of an impending blast. Two scare charges will be used for each blast. The detonation of the first scare charge will be at 45 seconds prior to the blast, with the second scare charge detonated 30 seconds prior to the blast. Some marine mammals and fish may not locate the origin of the first scare charge. The second scare charge allows these creatures to better locate the source of the charge and maneuver away from the source.

- Blast pressures will be monitored and upper limits will be imposed on each series of 5 blasts.

- Average pressure shall not exceed 70 pounds per square inch (psi) at a distance of 140 feet.

- Maximum peak pressure shall not exceed 120 psi at a distance of 140 feet.

- Pressure will be monitored for each blast only at a distance of 140 feet.

- Surveillance for schools of fish will be conducted by vessels with sonar fish finders for a period of 20 minutes before each blast, and if fish schools are detected, blasting will be delayed until they leave. The surveillance zone will be approximately circular with a radius of about 500 feet extending outward from each blast set.

Adverse impacts to fish will be further minimized by conducting blasting between December 1 and March 15 as recommended by the Delaware River Basin Fish and Wildlife Management Cooperative, and using controlled blasting methods such as delayed blasting and “stemming” to reduce the amount of energy that would impact fish. In addition, fish avoidance techniques will be utilized to drive fish away from the proposed blasting area to reduce the detrimental impact to the fish and benthic community. Monitoring impacts to fish from the blasting will also be conducted to verify that impacts are minimal.

The pre- and post-blast monitoring for fish including shortnose sturgeon shall be conducted under the supervision of a

principal biologist that has at least a Master of Science degree in fisheries biology or similar fields and must have obtained in their name the appropriate ESA permits to work with shortnose sturgeon.

6.0 Discussion/Conclusions

While the Corps plans to construct the majority of the deepening project within the dredging windows to protect threatened and endangered species, some portions of the project will need to be completed when species may be present in the project area. With regard to the protection of sea turtles, monitors are required to be on all hopper dredges working between June and November south of the Delaware Memorial Bridge. As shown in Figure 5, hopper dredging will be conducted in June in project Year 3 and in June, July and August in project Year 4. Hopper dredging will be conducted between June and November during project Years 5 and 6. This work is well above the area where turtles are expected to be found in the River and therefore would have no impact on the species.

While it is possible for shortnose sturgeon to become entrained in the dredge during dredging operations, the majority of potential impacts would be related to the blasting activities. In order to minimize these potential impacts, blasting is only scheduled to take place in December and January of project Years 1 and 2. Further measures being taken to minimize impacts to sturgeon were outlined above. The complete blasting plan was previously included in the 2000/2001 NMFS coordination and Biological Opinion which concluded that rock blasting conducted from December 1 to March 15 may adversely affect, but is not likely to jeopardize the continued existence of listed species under NMFS' jurisdiction.

Maintenance dredging of the project following the deepening will continue on a yearly basis as is currently done. It is expected that maintenance dredging will take place in the same channel ranges as it does now but that the quantity of material to be removed may increase by approximately 10%.

Through the implementation of the features described in this assessment to protect sea turtles, whales and the shortnose sturgeon, the Corps believes it will be possible to minimize and in some cases eliminate any impacts to the species. The Corps will continue to actively work with the NMFS, the states of Delaware and New Jersey, and the local communities to ensure that the planned activities will not negatively impact the populations' chances for survival.

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